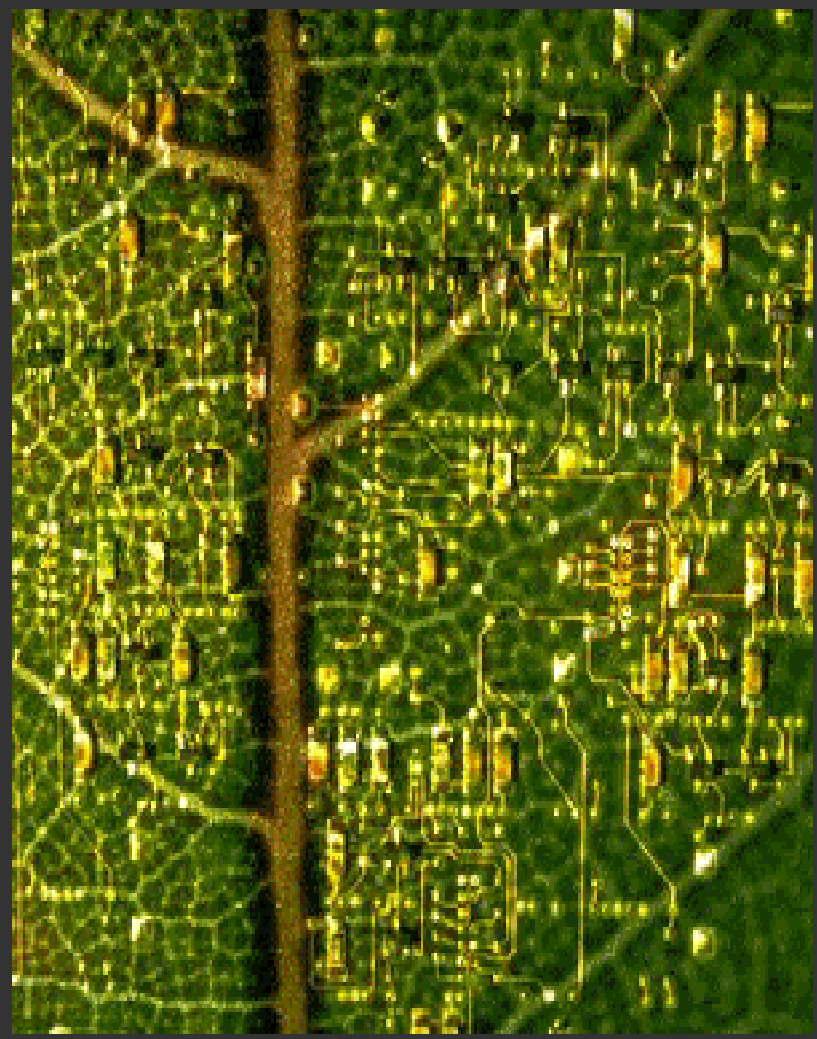
Delivering Sustainable Design in the Lab Environment

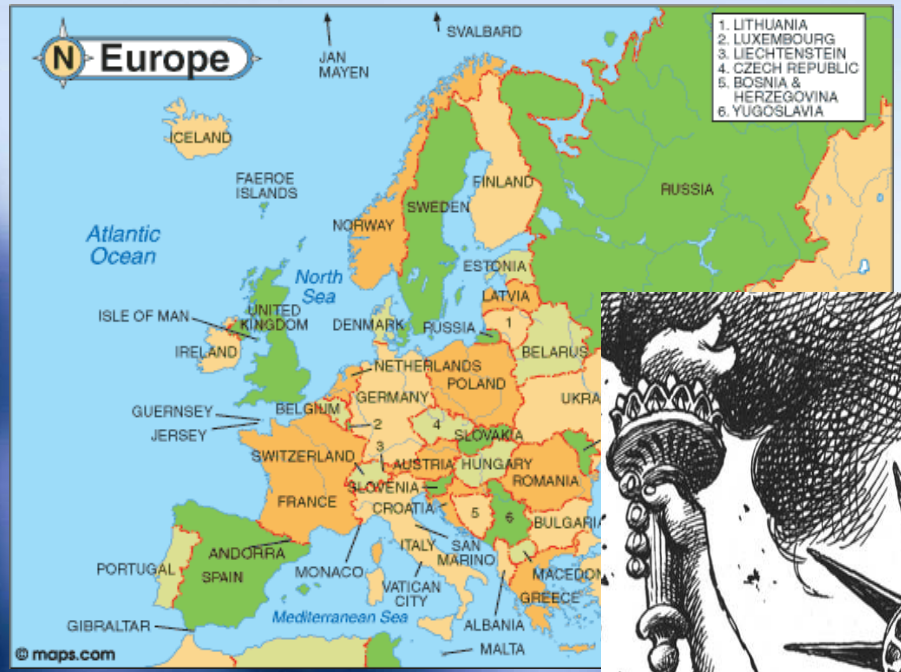
"Lessons Learned in the US and Abroad..."



Summary:

- Background
- Current Trends
- Case Studies
- Emerging Issues & Topics
- "The Way Forward"

- Your Speakers…
- Mike Walters, AEI
- Ben Shepherd, Battle McCarthy…

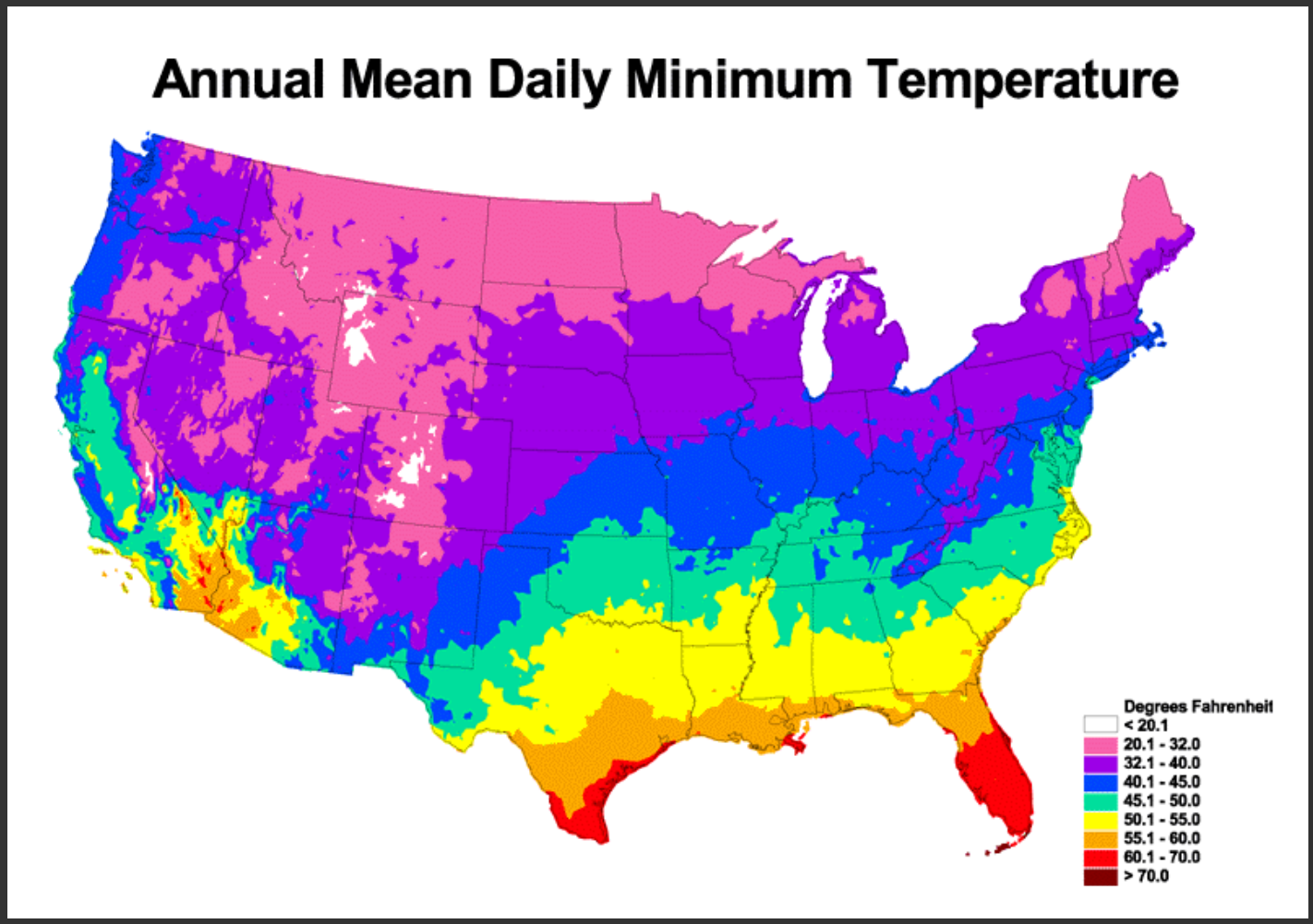


Europe & the US

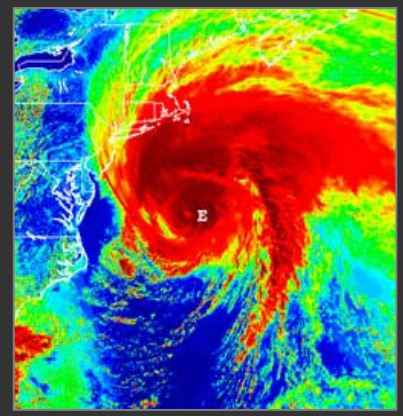
bulation

Use

ents


Annual Mean Daily Minimum Temperature
Degrees Fahrenheit
< 20.1
20.1 - 32.0
32.1 - 40.0
40.1 - 45.0
45.1 - 50.0
50.1 - 55.0
55.1 - 60.0
60.1 - 70.0
> 70.0

- Weather

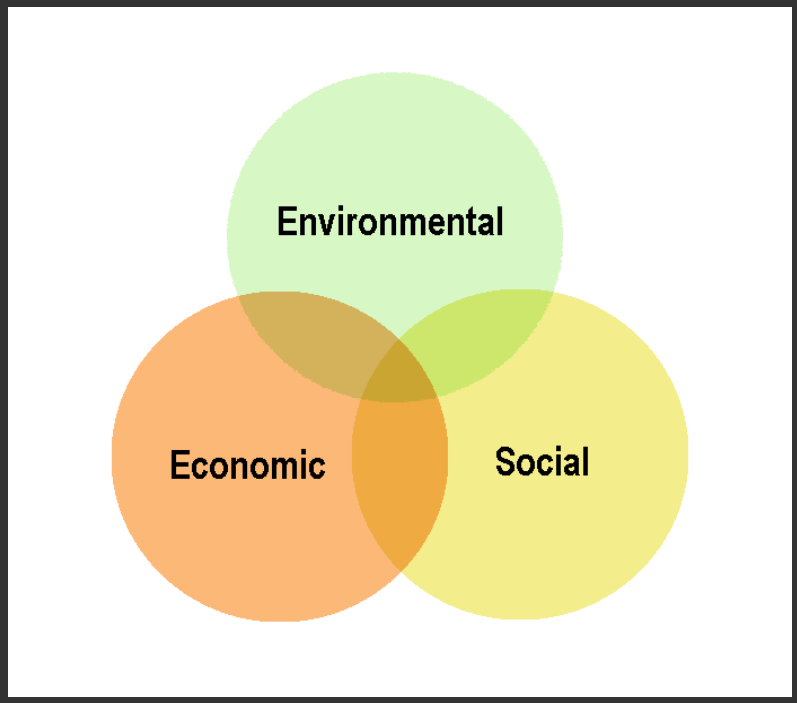


- Energy is CHEAP ?
- Perception that it costs more
- No real belief in integrated design
- Few products on the market
- Perceived increase risk of failure
- Clients do not see any real benefit

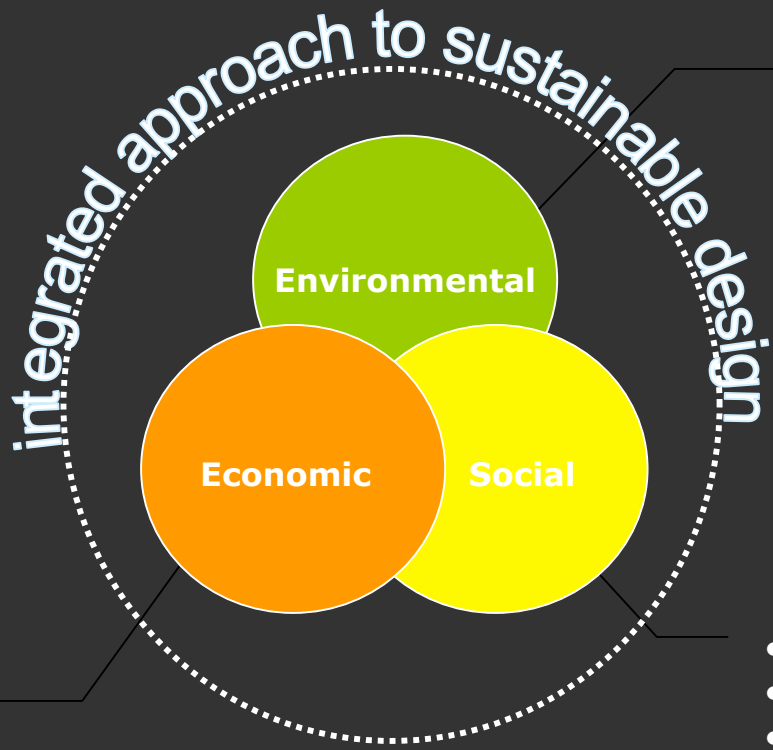
Sustainable Design is a fusion of:

- Resource efficiency — *maximizing the efficient use* of resources in the design, construction, development, & operations of buildings and communities
- Environmental sensitivity — *benefiting* the surrounding environment
- Attention to human well-being — *fostering community* in design, construction, and operations
- Financial success — *an important motivation for doing the right thing.* Sustainability is not an altruistic pursuit carried out by developers willing to lose money in the name of the environment.

Sustainable Design Approach:



- Whole-Systems Thinking
- End-Use/Least Cost Considerations
- Front-Loaded Design
- Teamwork

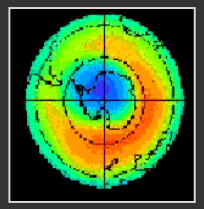


- Ecosystem integrity
- Carrying capacity
- Biodiversity

- Growth
- Development
- Productivity
- Trickle-down

- Cultural identity
- Empowerment
- Accessibility
- Stability
- Equity

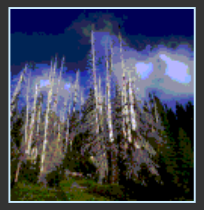
Global Environmental Issues



Ozone depletion

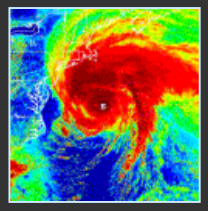
Biodiversity loss

Fuel depletion



Acid rain

Land depletion



Climate change

Waste generation

Water depletion

Laboratories

- Close control
- Highly serviced
- Clean rooms
- Controlled lighting
- Efficient systems
- Controlled Daylighting
- No sun

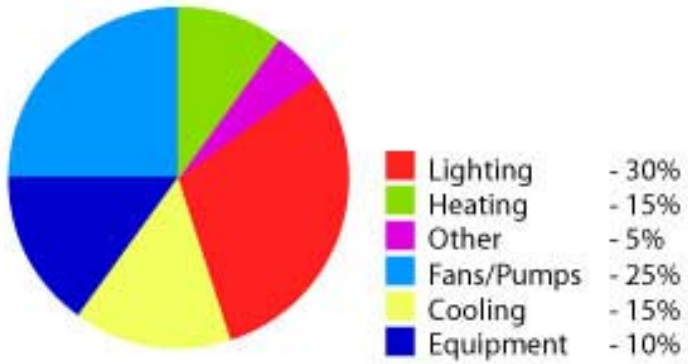
Admin / office

- Medium control
- Daylighting
- Nat vent (25%)
- Solar control
- Comfortable
- Flexible

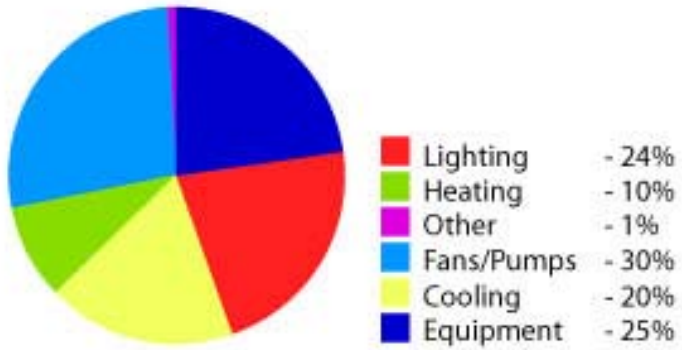
Foyer

- Loose control
- Daylighting
- Solar heating
- Passive cooling
- Natural ventilation
- Mixed mode

Typical Energy Breakouts:

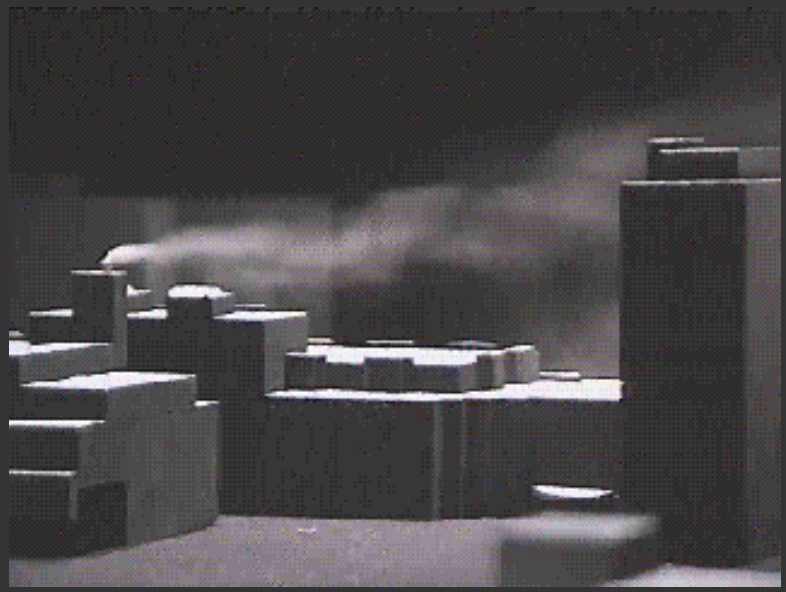


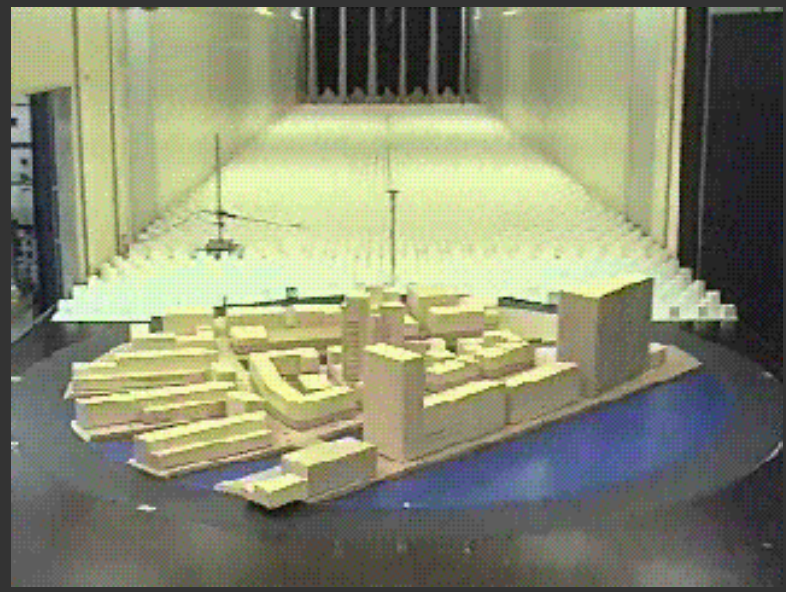
Administrative/Support



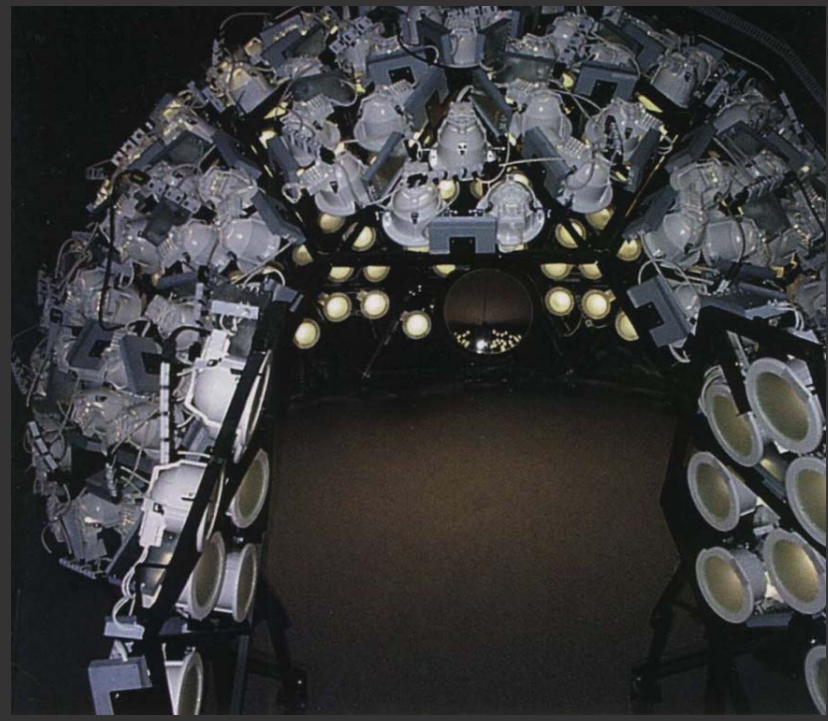
Laboratory

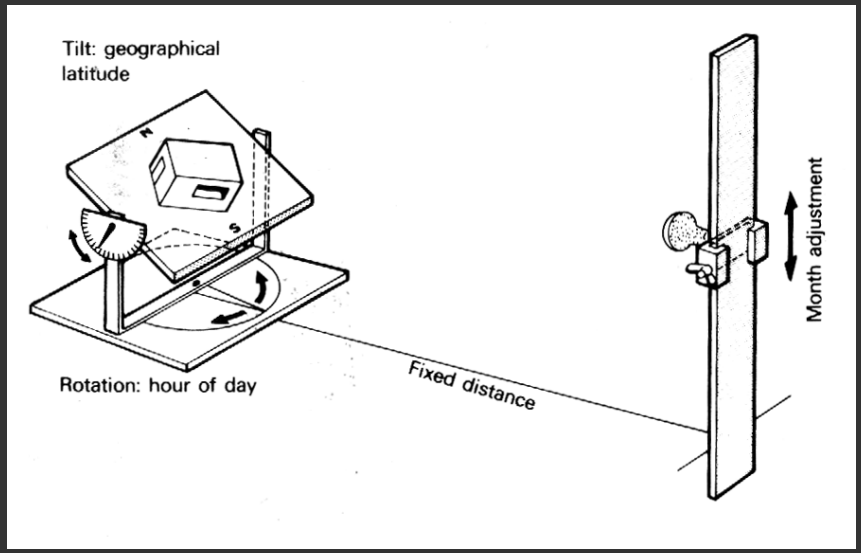
- Study of air movement
  - Atmospheric boundary layer wind tunnel
    - Wind distress studies
    - Wind discomfort studies
    - Cladding pressures
    - Structural loadings
    - Surface pressure distributions

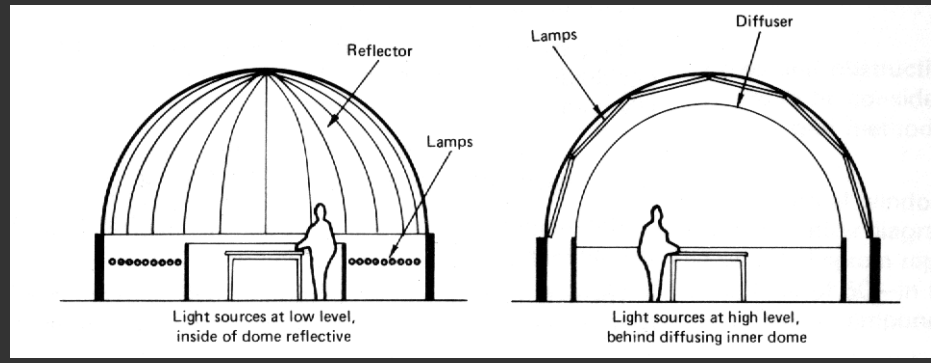


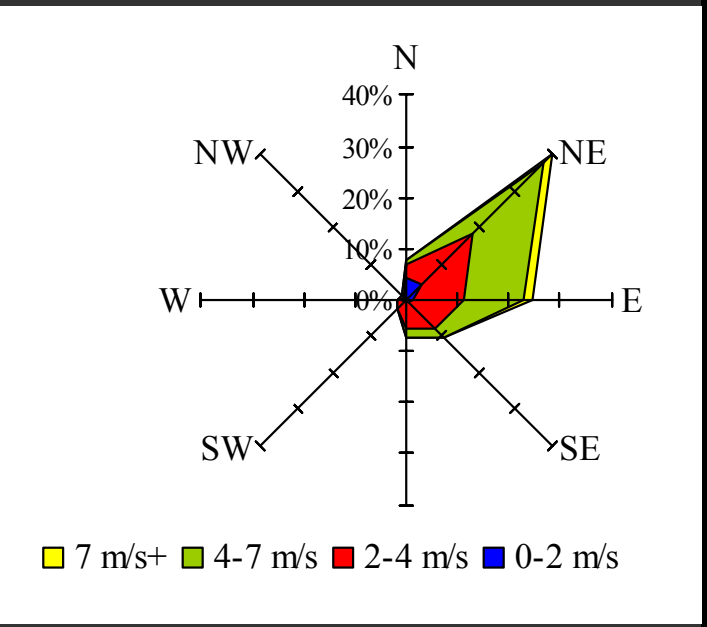


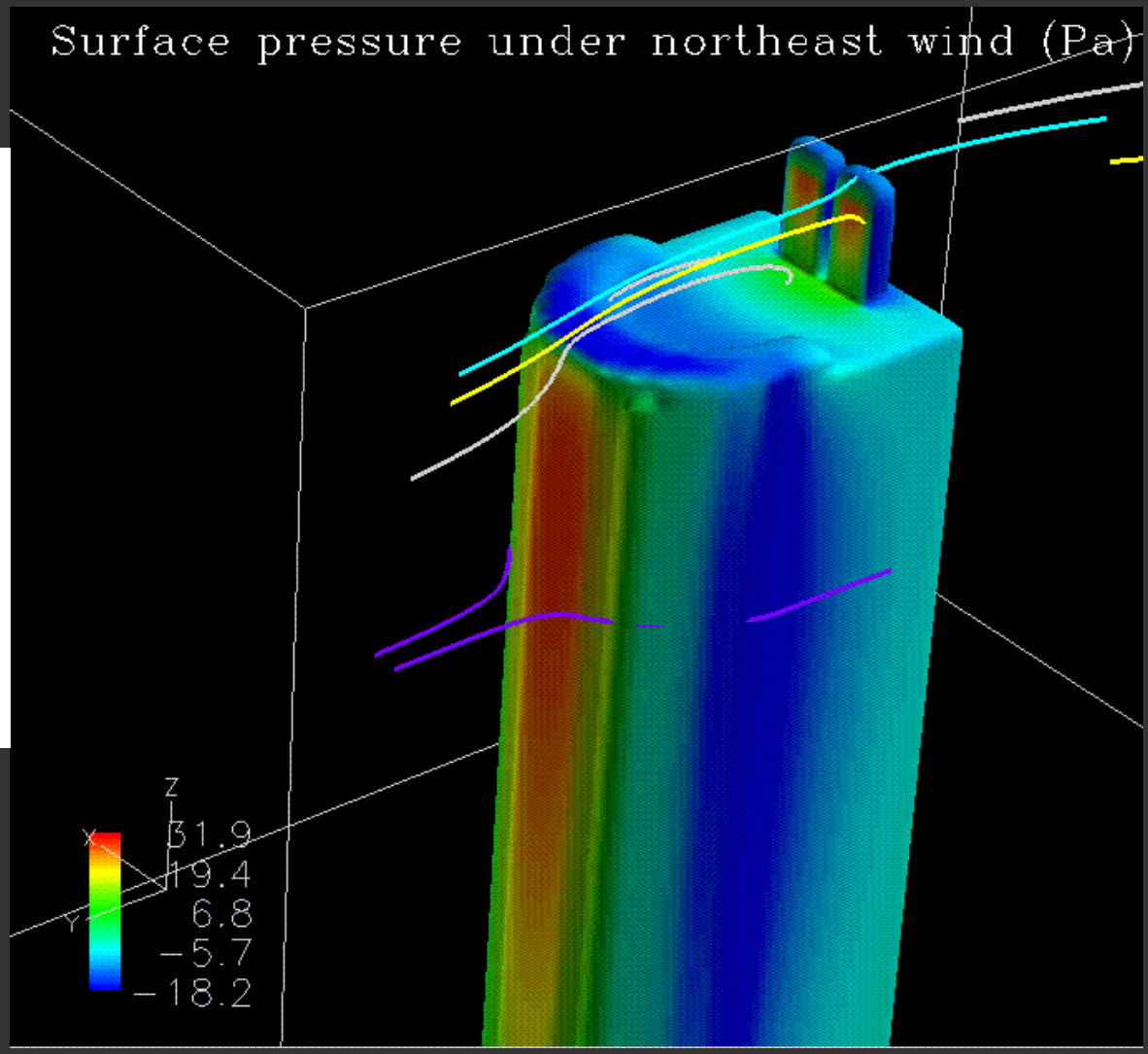
- Study of daylight movement
  - Heliodon and artificial Sky
  - Ray tracing methods
    - Radiance
    - Genelux
    - CAD








N
NE
E
SE
SW
W
NW
40%
30%
20%
10%
0%
7 m/s+
4-7 m/s
2-4 m/s
0-2 m/s


Surface pressure under northeast wind (Pa)
Z
31.9
19.4
6.8
−5.7
−18.2

CASE STUDIES

- Johnson & Johnson project- AEI

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- Genentech- AEI
- CA low-flow fume hood

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- Wrigley Lab Project- BM
- Chicago, IL
- Zoning
- Renewables

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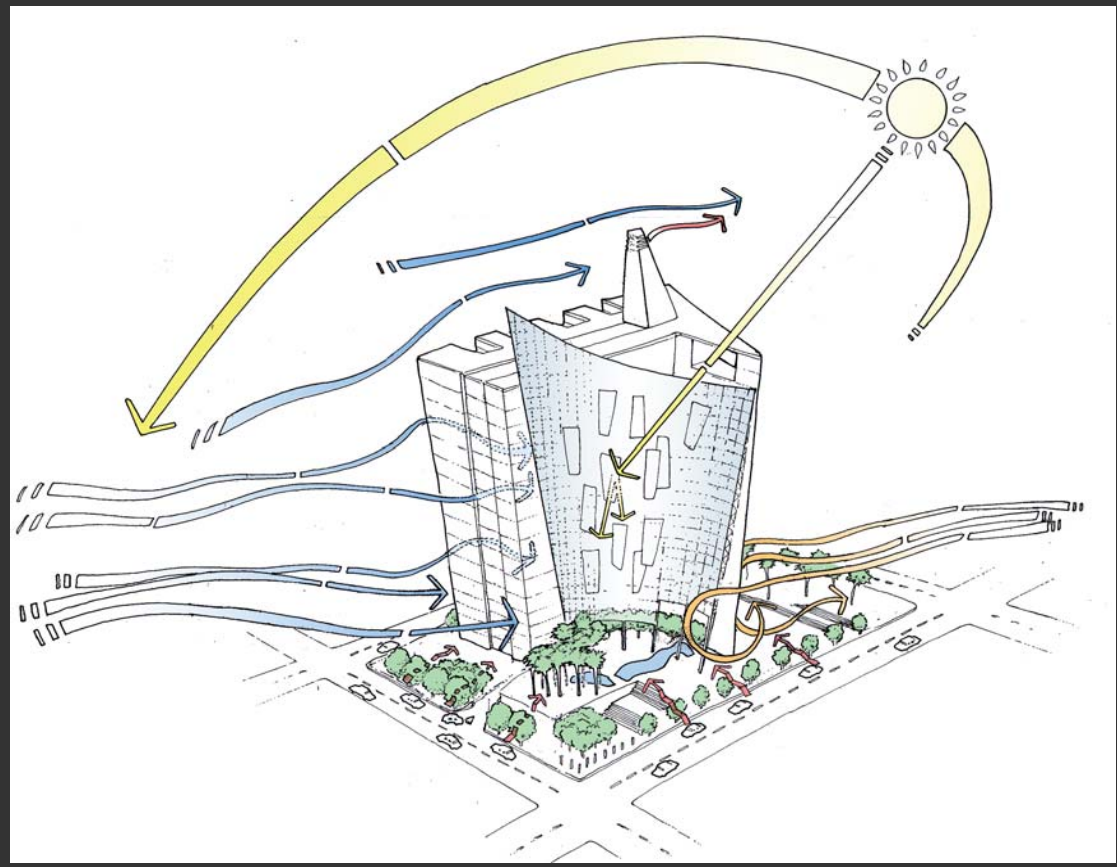
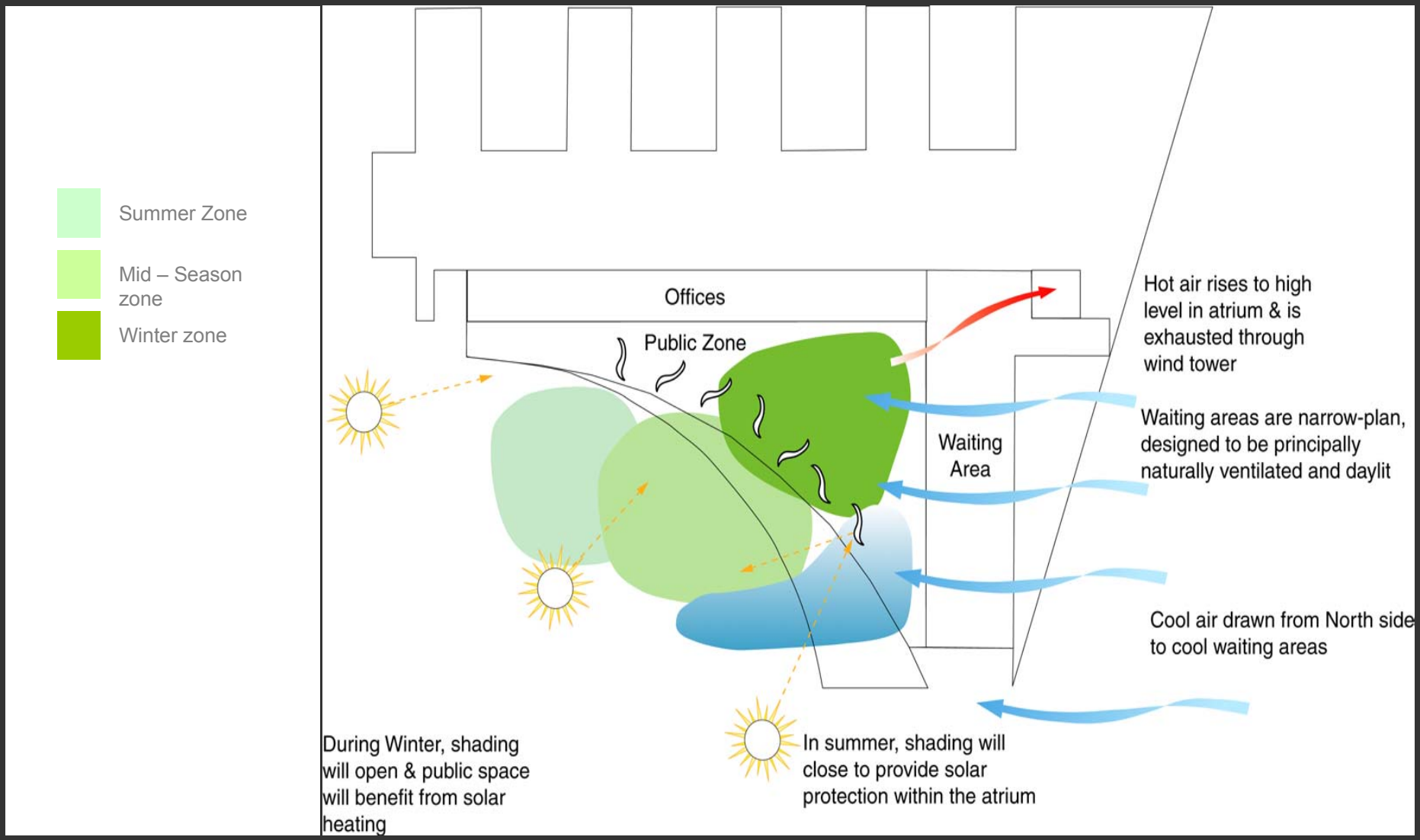
Case Studies- LA Courthouse

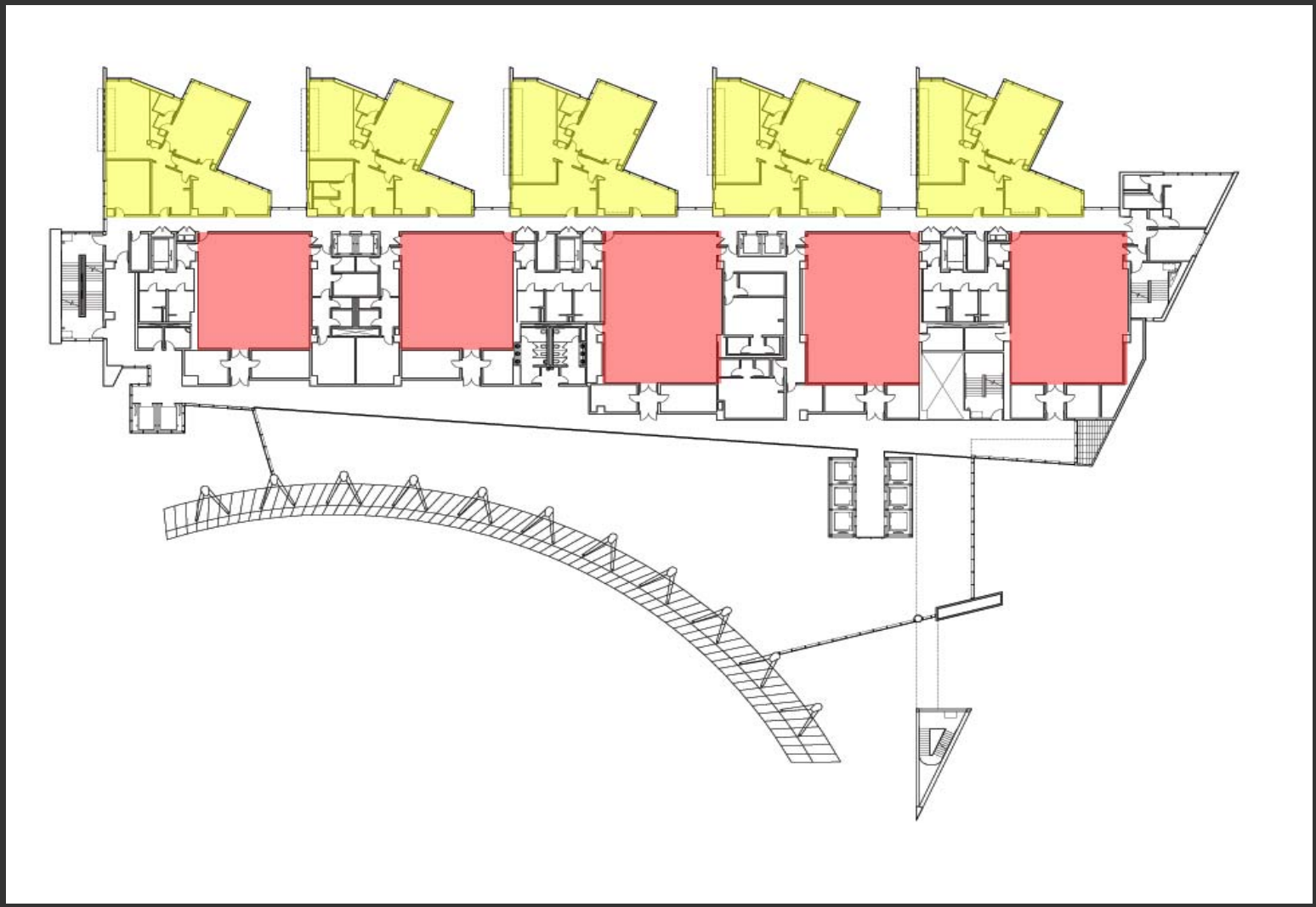
- XX,XXX SF
- Federal GSA project
- Daylighting
- Solar PV
- Interior Atrium



A Seasonal Space

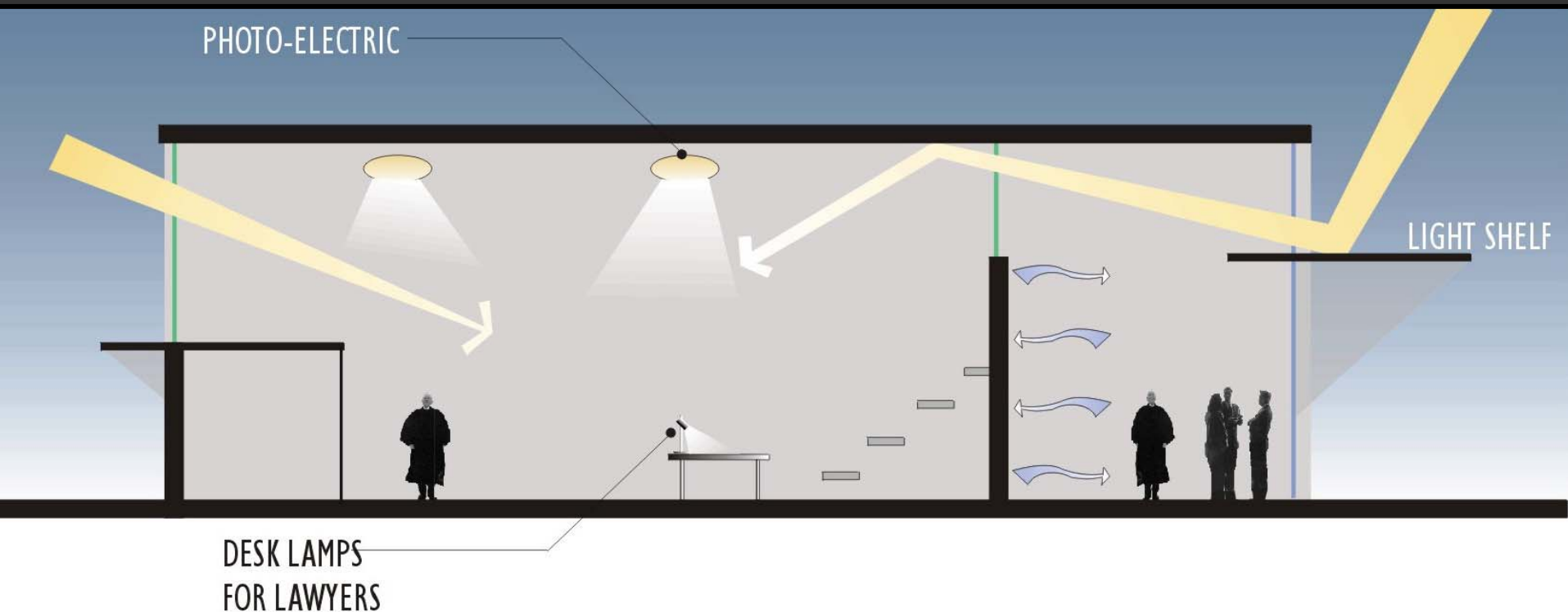


Thermal Mass & Passive Cooling



Daylighting

- Courthouse Day Lighting Applications



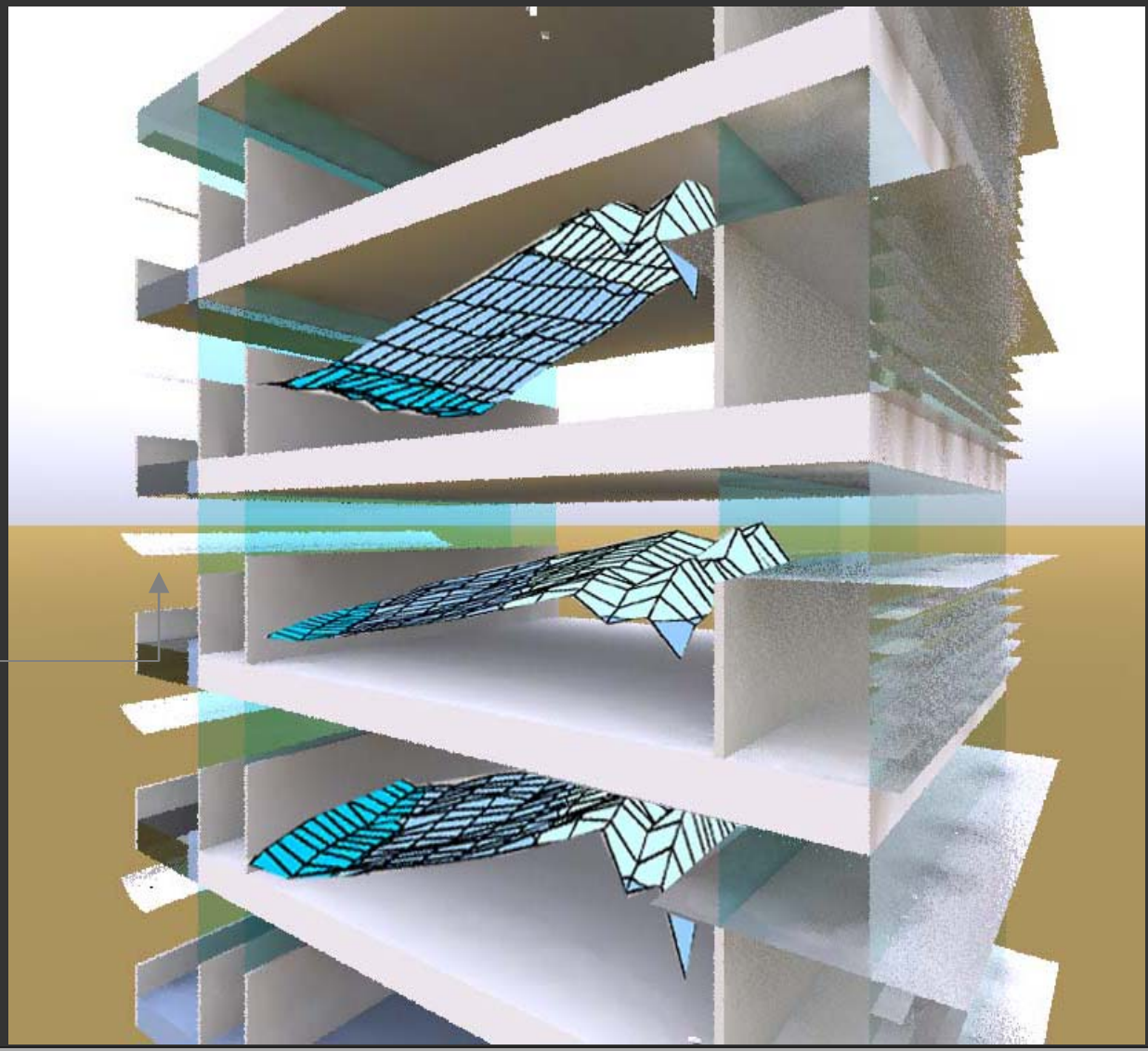
Daylit Courtrooms

Items	Results	Target
Av. DF 5%	3.7%	3 –
Min. DF	2.9%	2%
Uniformity	0.77	0.4

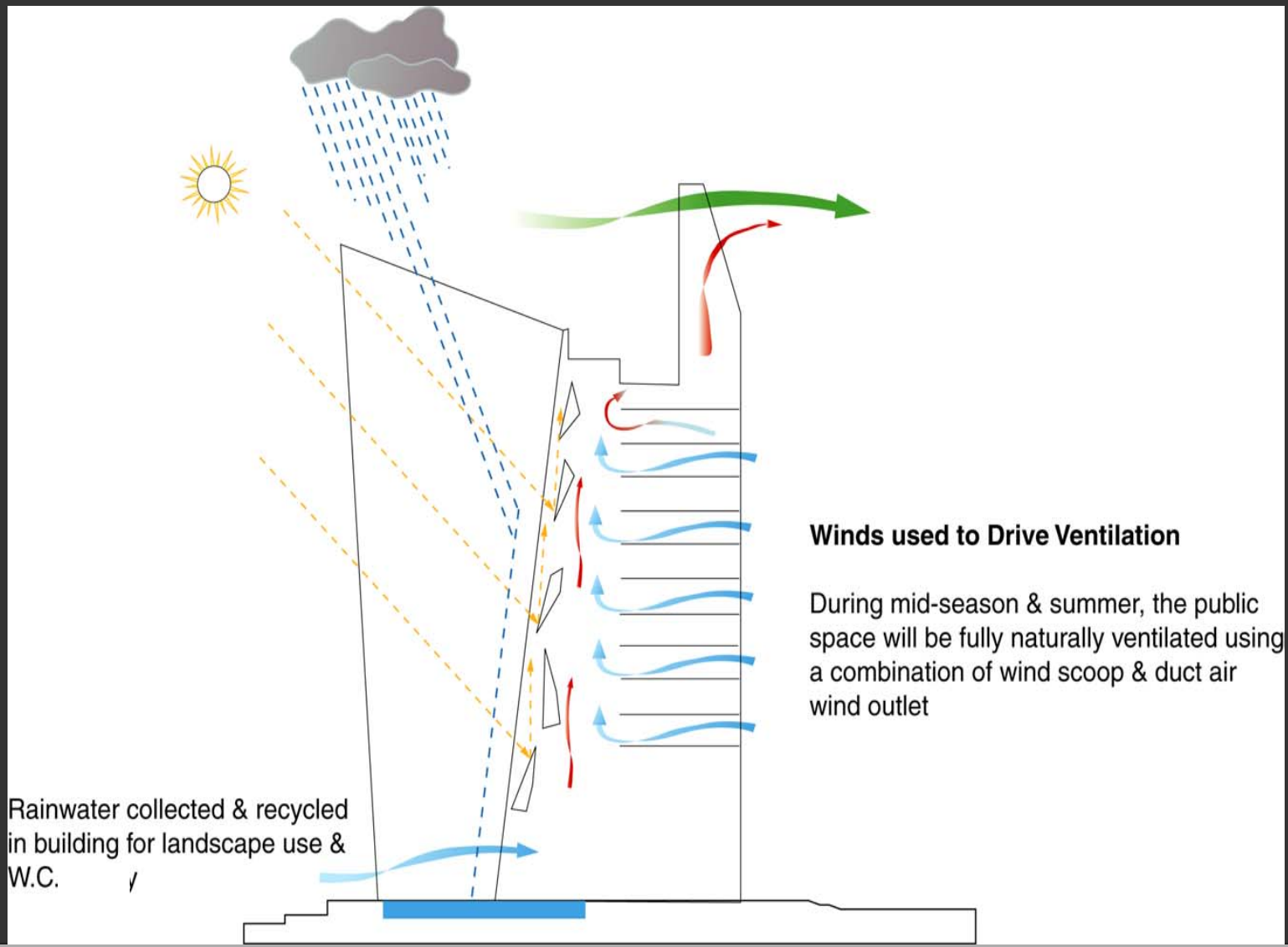
(Where DF stands for daylight factor)

A totally daylit courtroom is achieved

Light – Shelves are used to relect light deep into the courtroom and are designed to provide glare free natural light

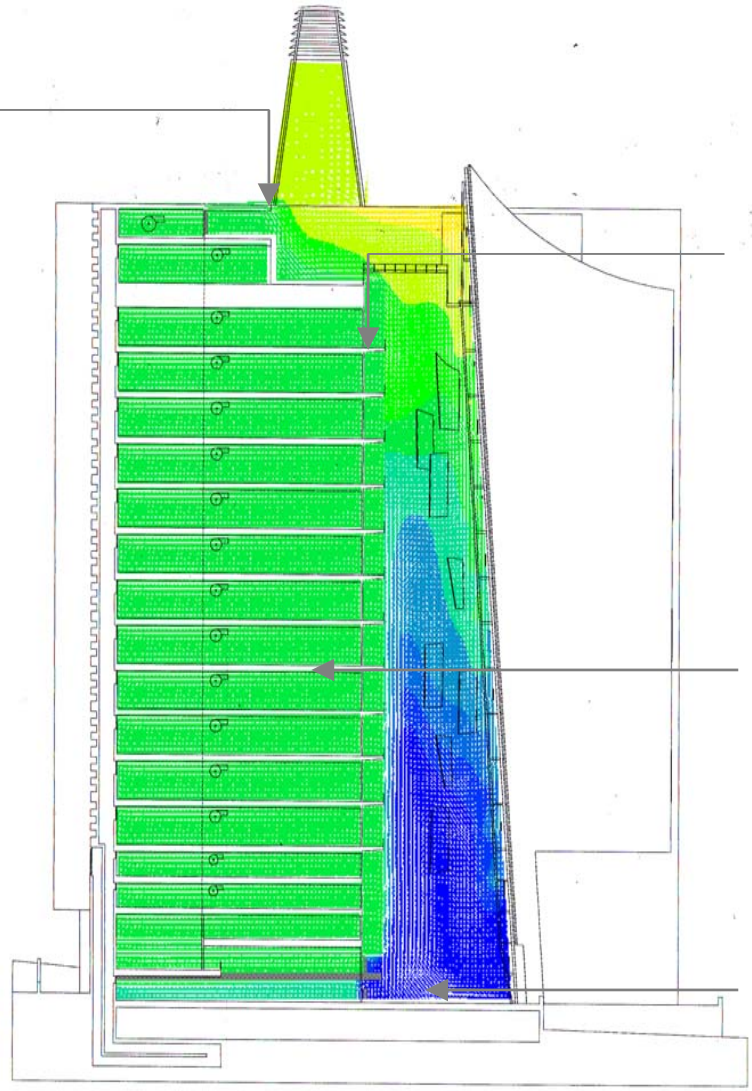


Wind used to Drive Ventilation



Wind & Solar Driven Ventilation

Wind Tower exhaust, located well above the building in region of low pressure formed by interaction of building with prevailing wind systems, it effectively sucks air out.

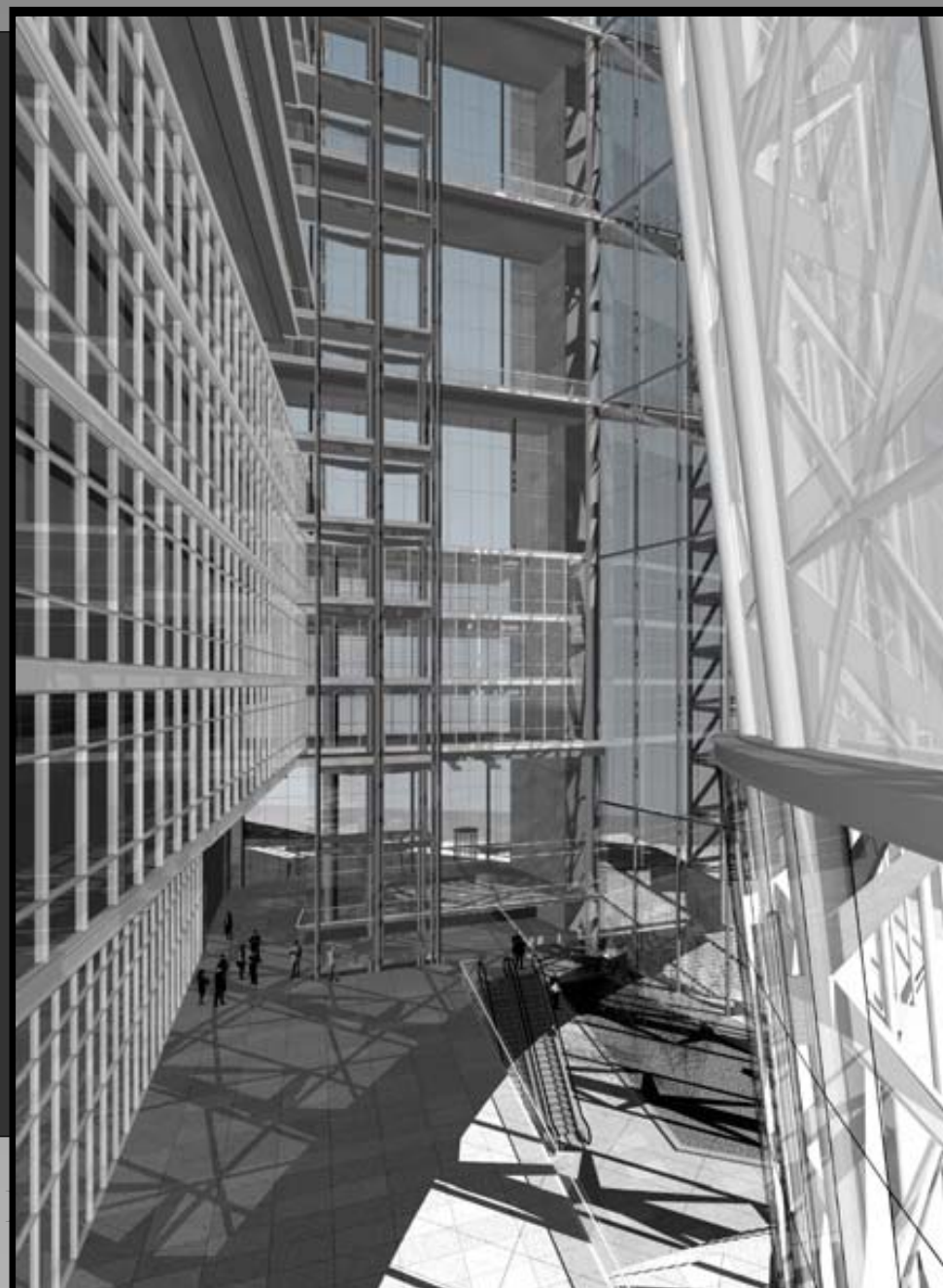


Solar gain and other heat sources within atrium increasing buoyancy of air, increasing ventilation rates

Air is recycled from courtrooms to provide free cooling into atria space when needed

Cool air drawn in from low level and through waiting zones on each floor

- Blast Resistant Glass / Mesh Wall
- “Invisible Fortress”



The N.I.H. Mission Statement

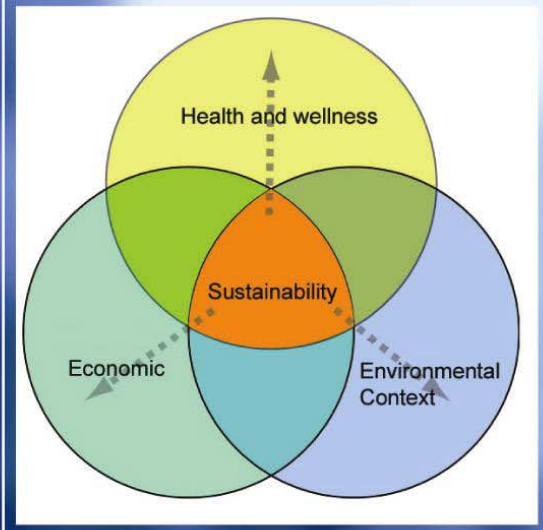
" The National Institutes of Health is the steward of medical and behavioral research for the Nation. Its mission is science in pursuit of fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to extend healthy life and reduce the burdens of illness and disability"

A Sustainable Development Initiative for NIH Should Deliver:

- Significant operational costs savings
- % Capital cost savings within agreed ROI
- Healthier working environment
- Increased research output
- A supportive local community
- National recognition of contribution

And…

- Be a catalyst for change



Core Principles

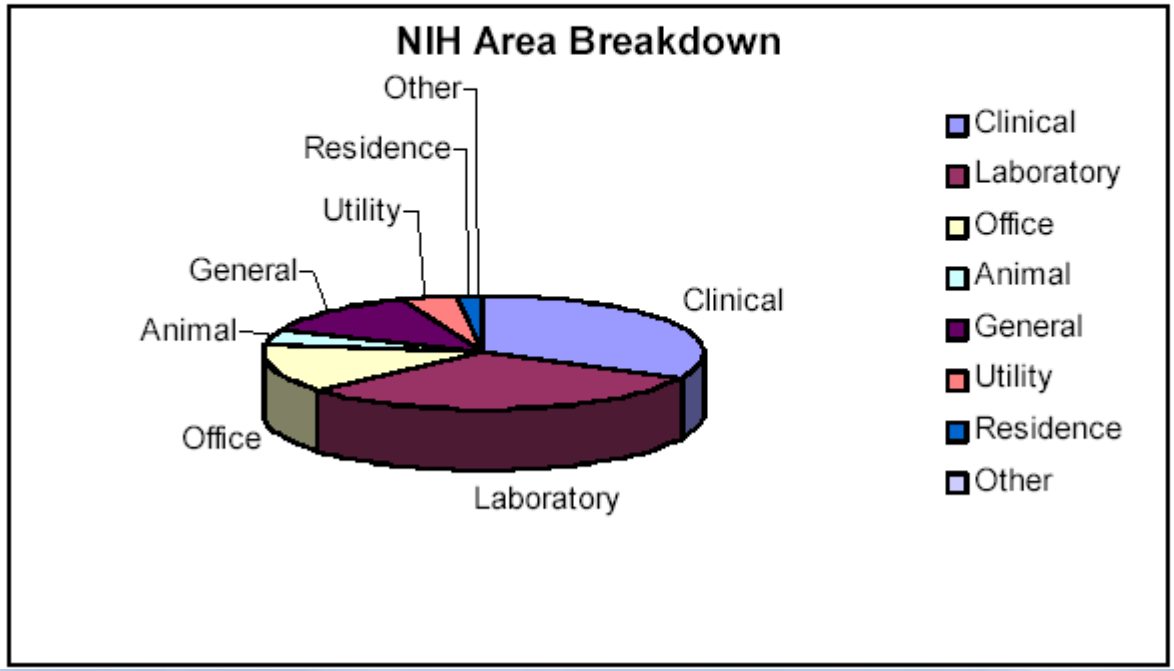
- **Health and Wellness**
  Provide an environment, both internal and external, that reduces health problems; improves productivity and performance; and delivers a better quality of life.

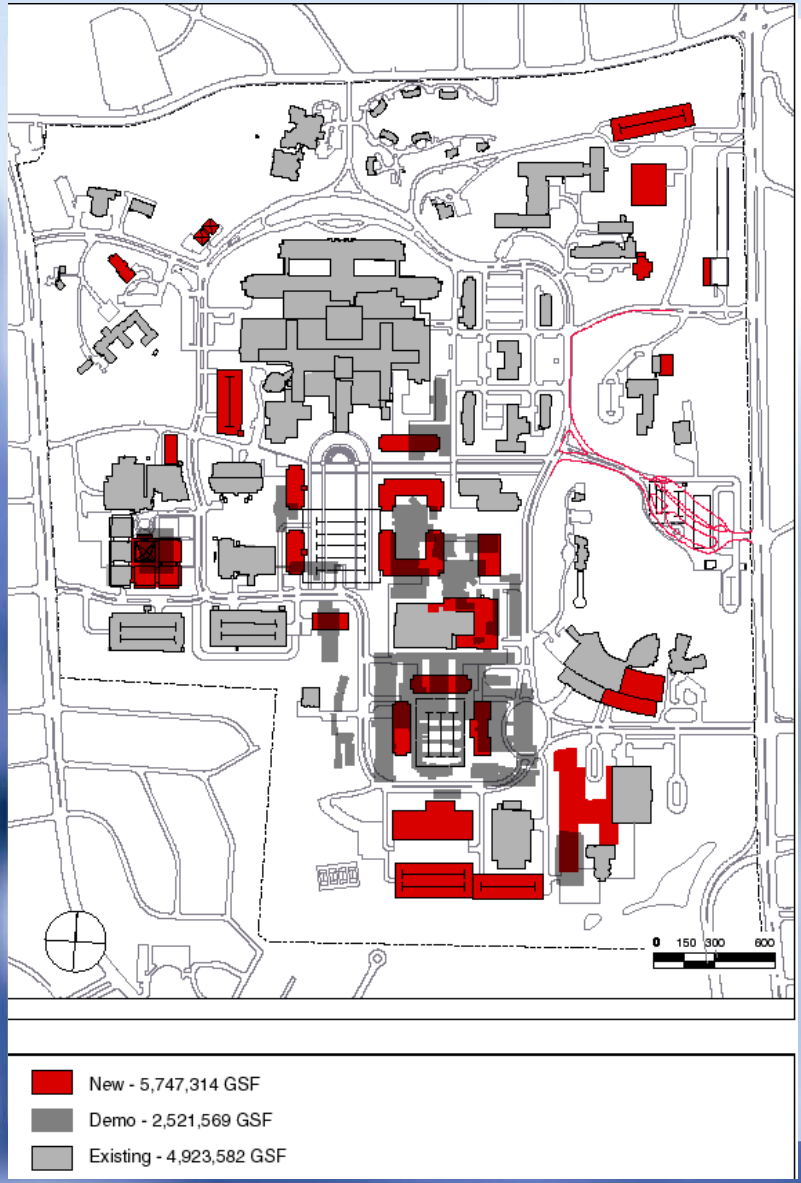
- **Economy**
  Ensure the efficient management of NIH from a Life-Cycle Analysis approach for buildings and functions, and to the wider economic impact of the campus on the region.

- **Environmental Context**
  Establish NIH as a leader in environmental performance, while improving efficiency and reducing the environmental impact of the campus at local, regional and global levels.

What is NIH?

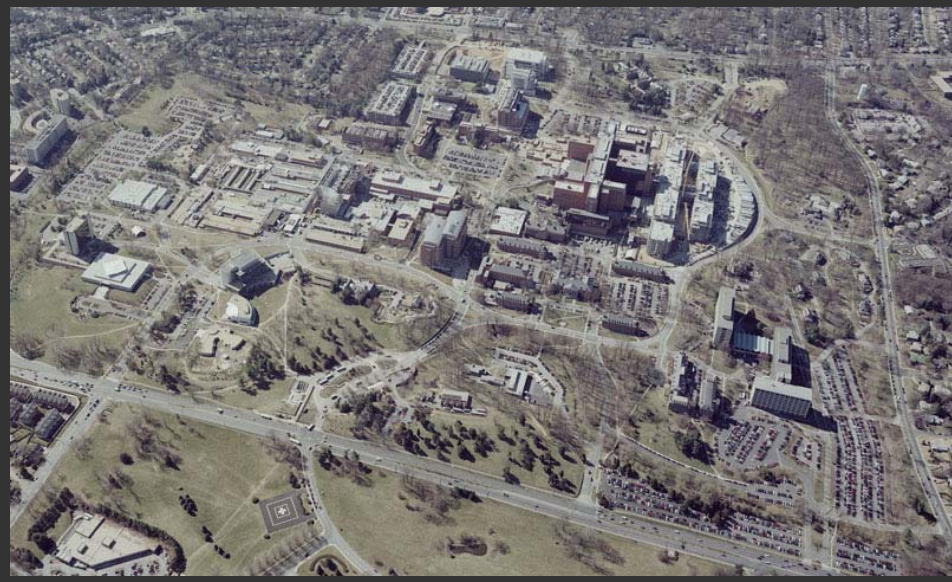
Clinical	Laboratory & Support	Office	Animal	General Support	Utility	Residence	Other	
2402400	2333236	1039964	288772	926097	318117	112565	24000	7445151 gsf





The Buildings of NIH:

- Existing/ Retrofits
- Additions
- New Construction
- Changing & Evolving Campus



Energy: $40 million spent annually;

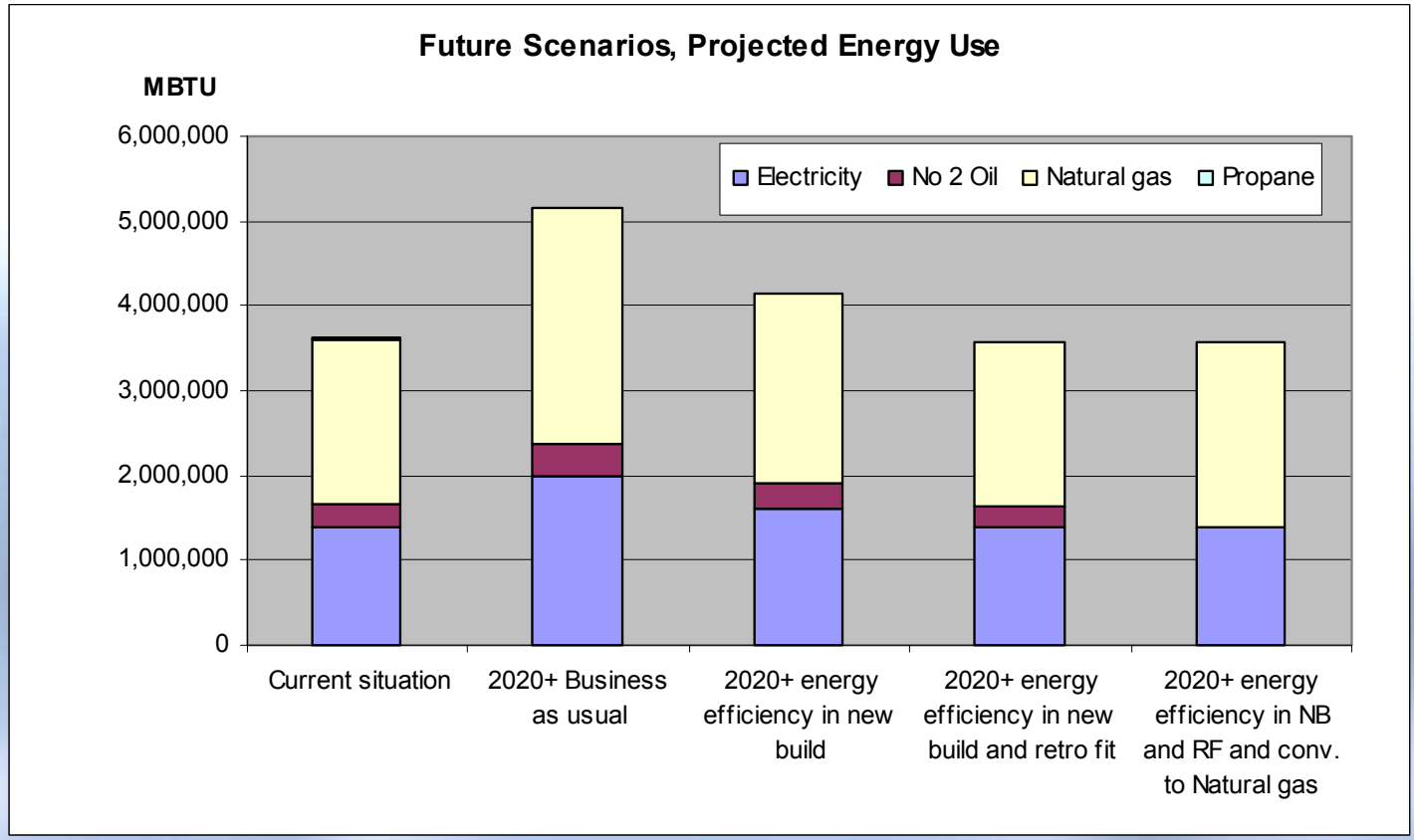
Water: Average 1.68 million gallons used daily;

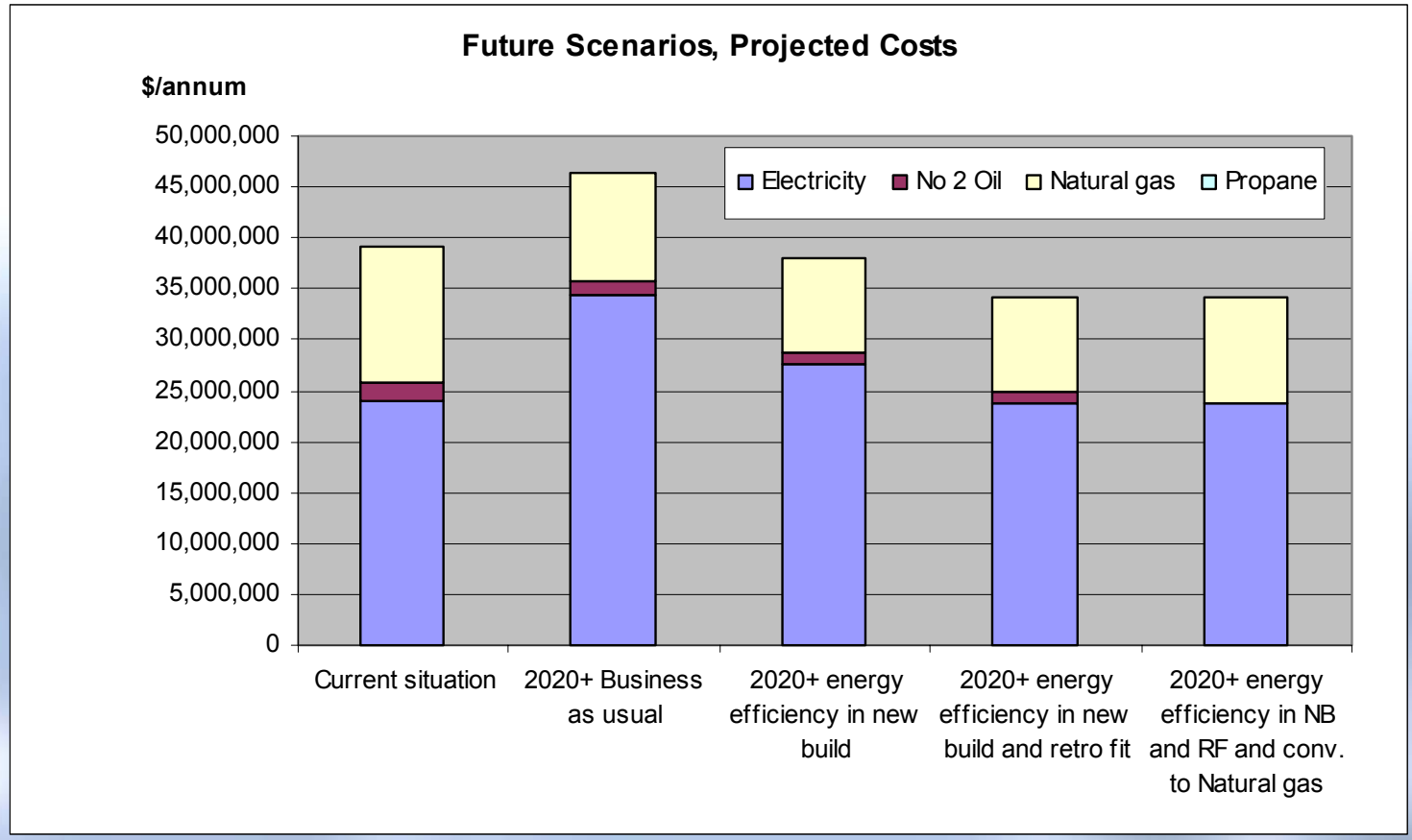
Waste: Approximately 14,200 tons generated annually;

Economic Impact: $1.7 billion in regional economic stimulus, 63,000 jobs.

Energy

- ~$40-50 million spent annually on total utilities
- 5.8c/kWh rate
- 46MWh total load
- New CHP plant is expected to provide about half of the campus use


Future Scenarios, Projected Energy Use
MBTU
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Electricity
No 2 Oil
Natural gas
Propane
Current situation
2020+ Business as usual
2020+ energy efficiency in new build
2020+ energy efficiency in new build and retro fit
2020+ energy efficiency in NB and RF and conv. to Natural gas


Future Scenarios, Projected Costs
$/annum
50,000,000
45,000,000
40,000,000
35,000,000
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
Electricity
No 2 Oil
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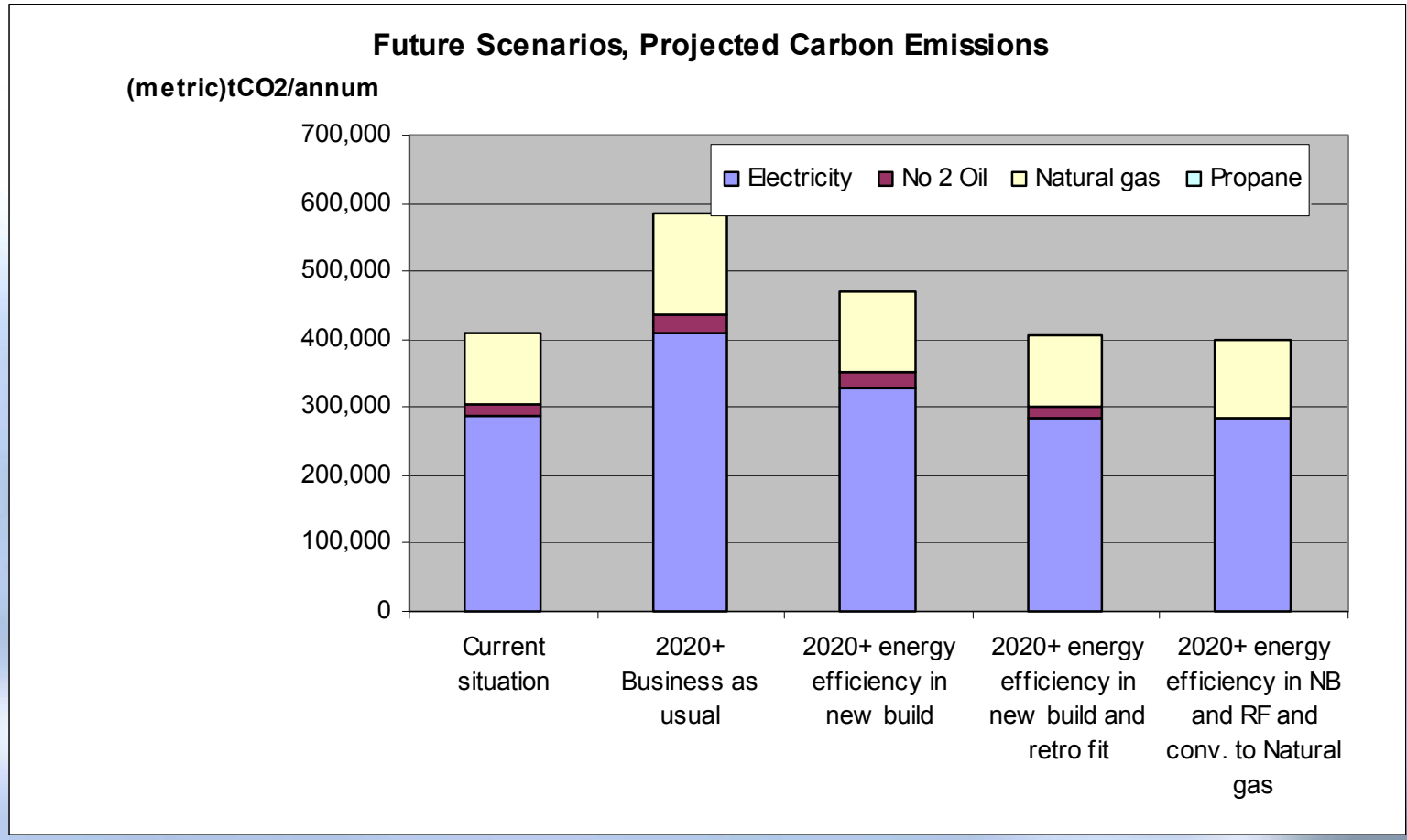
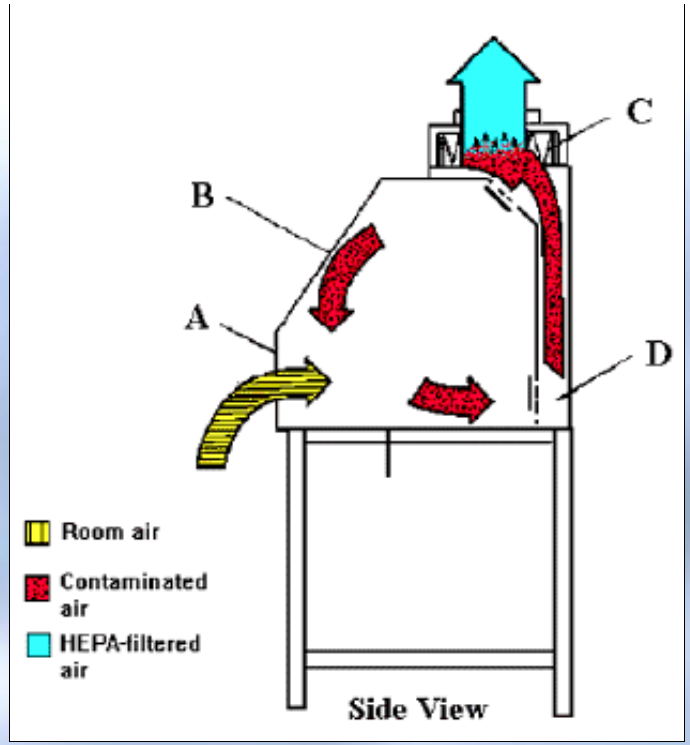
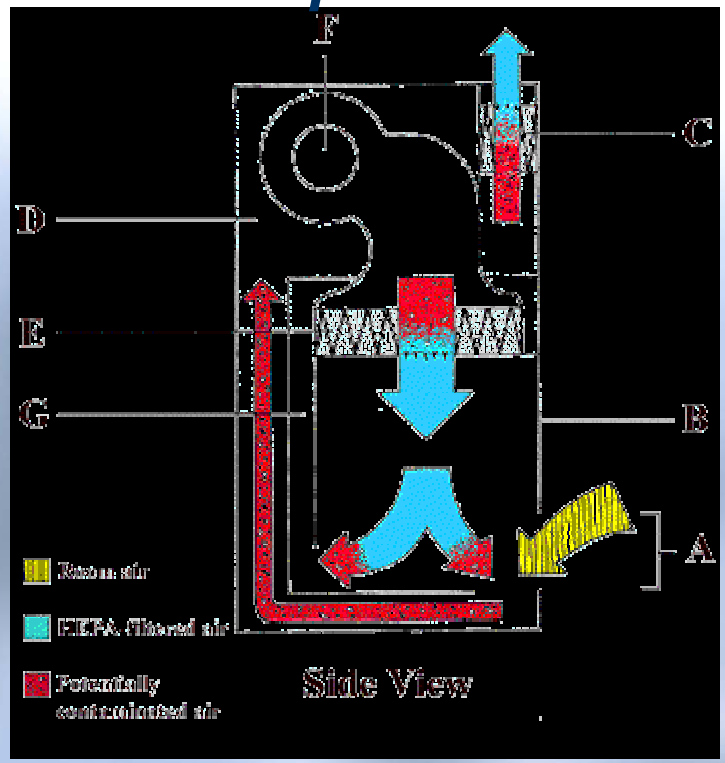

Future Scenarios, Projected Carbon Emissions
(metric)tCO2/annum
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Electricity
No 2 Oil
Natural gas
Propane
Current situation
2020+ Business as usual
2020+ energy efficiency in new build
2020+ energy efficiency in new build and retro fit
2020+ energy efficiency in NB and RF and conv. to Natural gas

The Labs of NIH

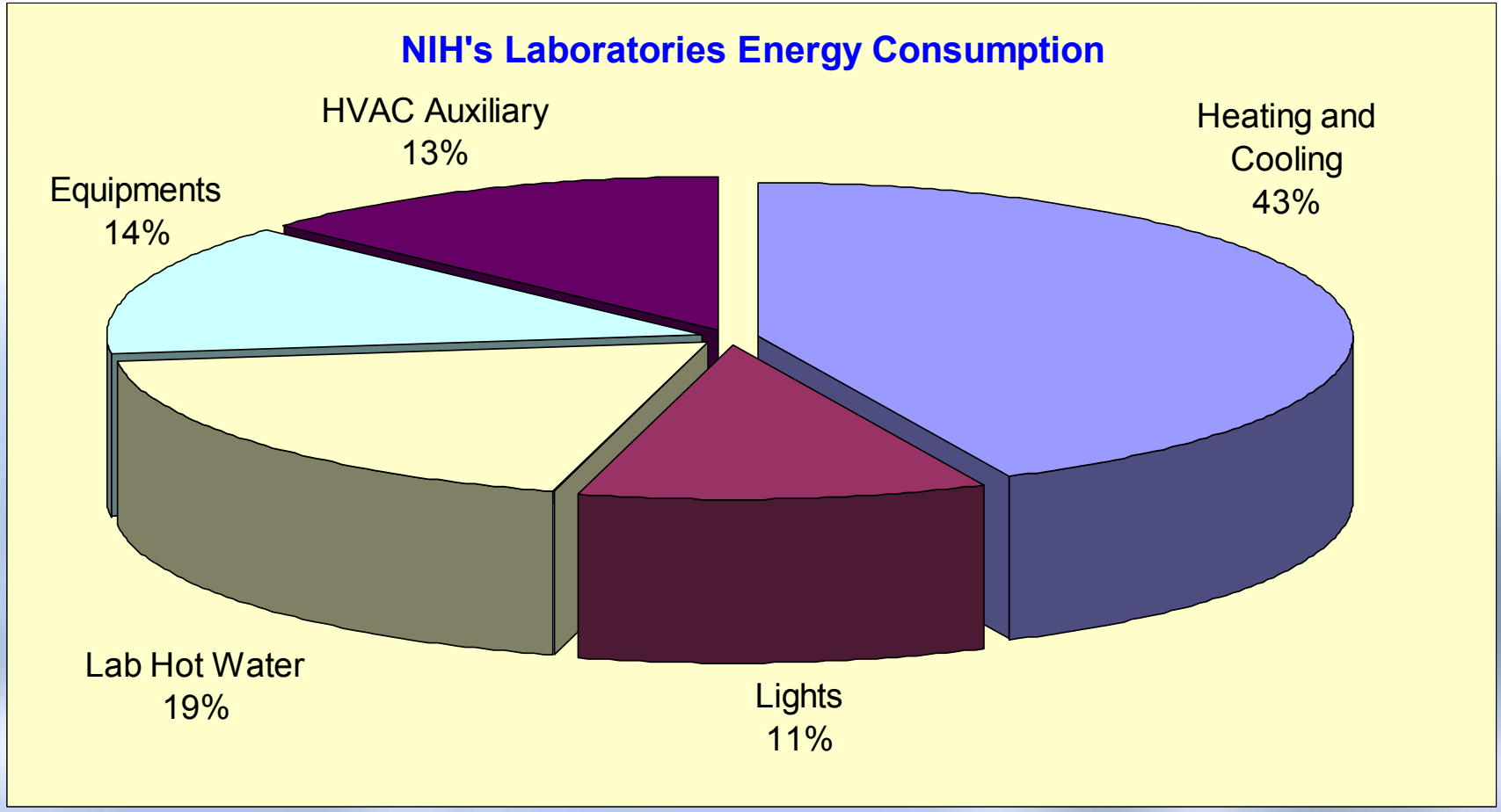
~2.3 million SF of the Bethesda Campus



BL1



BL2



**Labs are currently designed to 15w/SF minimum*


NIH
SDI

Health and Wellness

Environmental Degradation is Harmful to Human Health

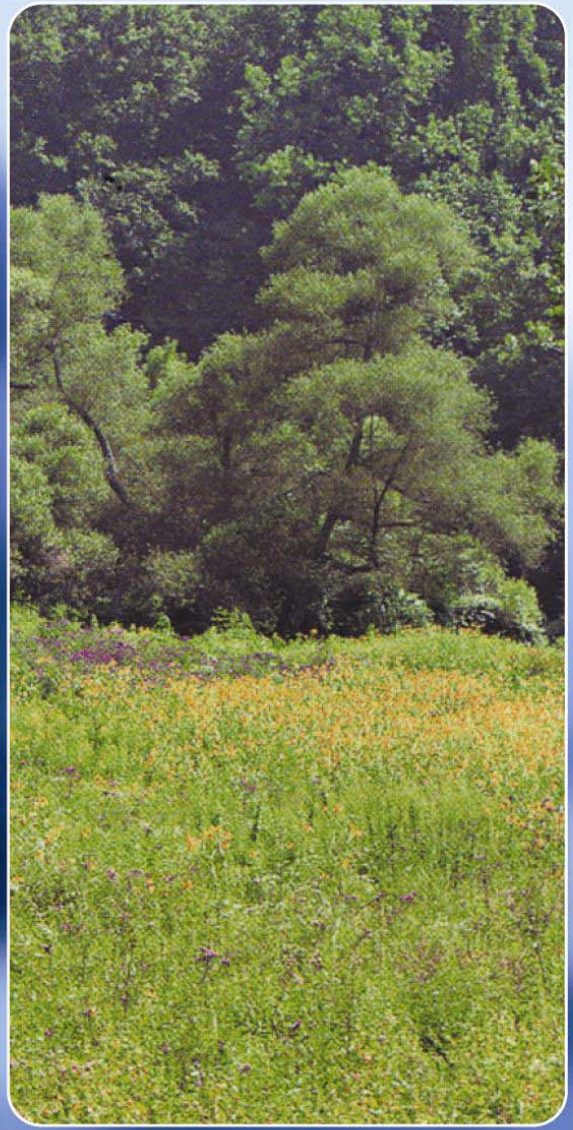
- A core goal of sustainable design is to halt further degradation and restore environmental quality.

Reducing risks is a necessary, but insufficient, way to improve health.

- We need to know what to ADD to buildings and the landscape to promote health and well being – not just what to get rid of.

Sustainable Design

	Risk Reduction	Wellness promoting
Site	Reduced air pollution Improved water Reduced noise	Enhanced outdoor greenspace Natural play areas for children Organic gardens Water features Habitat for birds Outdoor social spaces
Building	Improved indoor air Improved ergonomics	Access to daylight and sunlight Access to views Connections to nature Natural ventilation Personal control Improved wayfinding Meeting and greeting spaces



Benefits of Nature

- Accrue across the life span
- Include many types of interaction - active and passive
- Include physiological, cognitive, emotional and social benefits

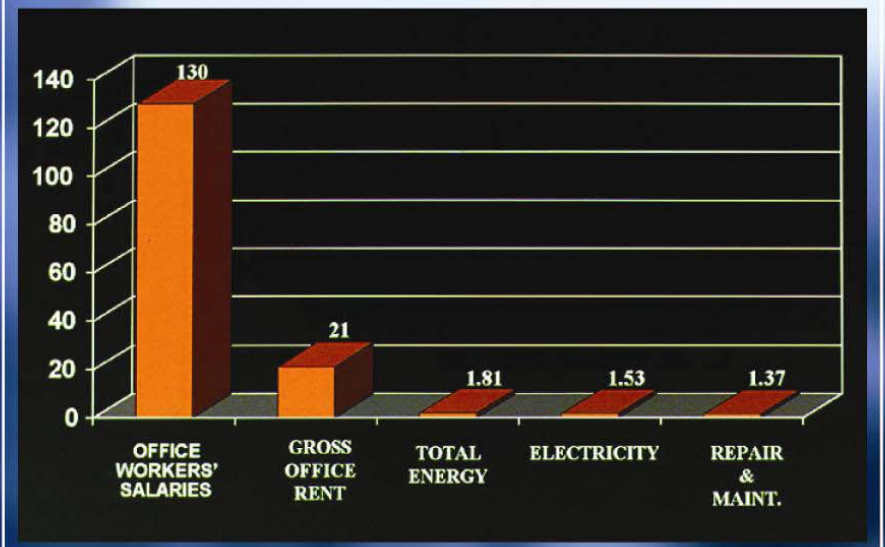
Benefits to the Organization

- Quality of work life
- Individual and group work effectiveness
- Attraction and retention
- Capacity for innovation
- Image and reputation
- Social responsibility
- Operational efficiency

Other Considerations

- High technology use – how to make it as sustainable as possible;
- Equitable distribution of sustainability benefits;
- Selling the benefits requires a value proposition at all levels – organization, department, work group, and individual.

Average Cost per SF

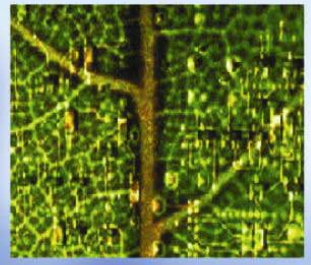


Source: RMI/BOMA 1990 data

Payback & Productivity

We often focus on the price of construction, maintenance, energy or overall rent associated with developments.

- The true cost and value of our buildings lies in the occupants;
- Recent studies have shown productivity increases for office workers of 6-16%;
- Daylighting measures have been shown to improve test performance for school children upwards of 20%.



Economic

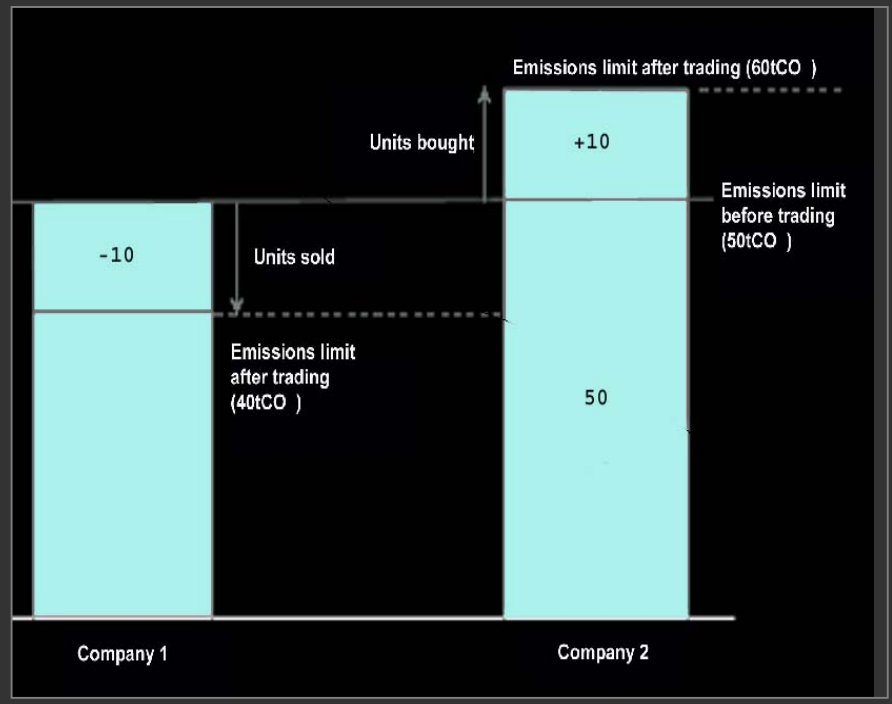
- Benefits of Sustainable Design lie in comprehensive, value-added approach to site, buildings, and infrastructure;

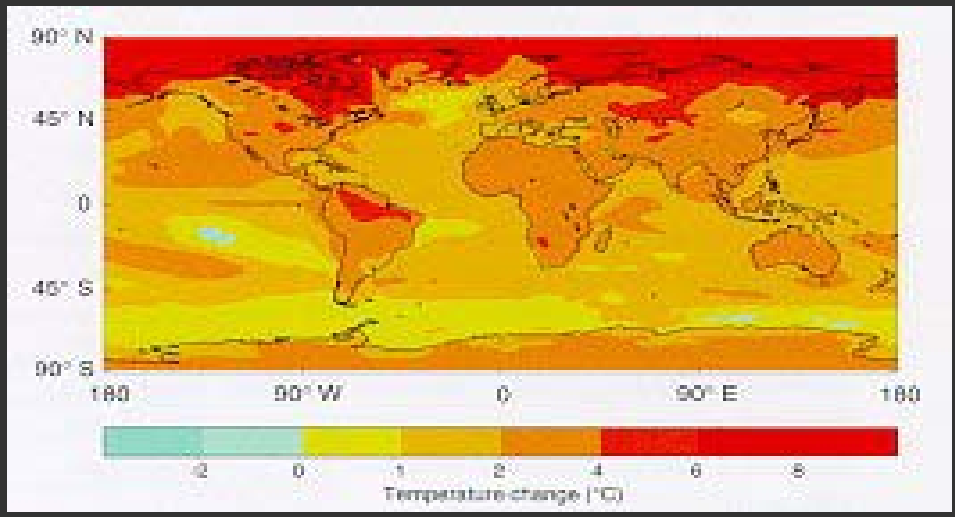
- Life-Cycle Cost Analysis focuses on the life-span of the building and future operational costs.

The GSA is the largest holder of Federal real-estate and currently has 19 projects working towards a LEED green building rating.

Blue Vervain helps eliminate
toxics through the pores

Carbon Strategies





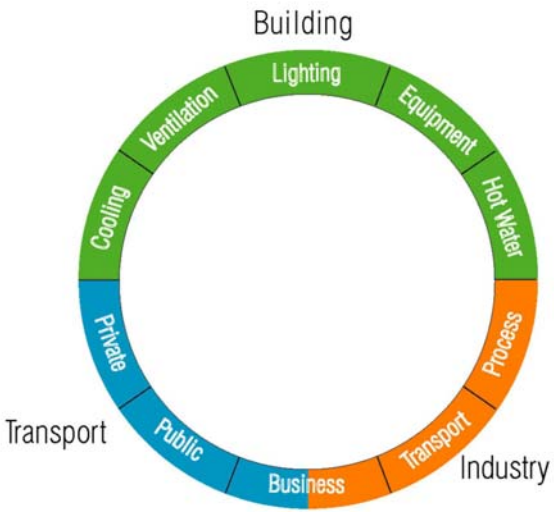
Carbon Strategies

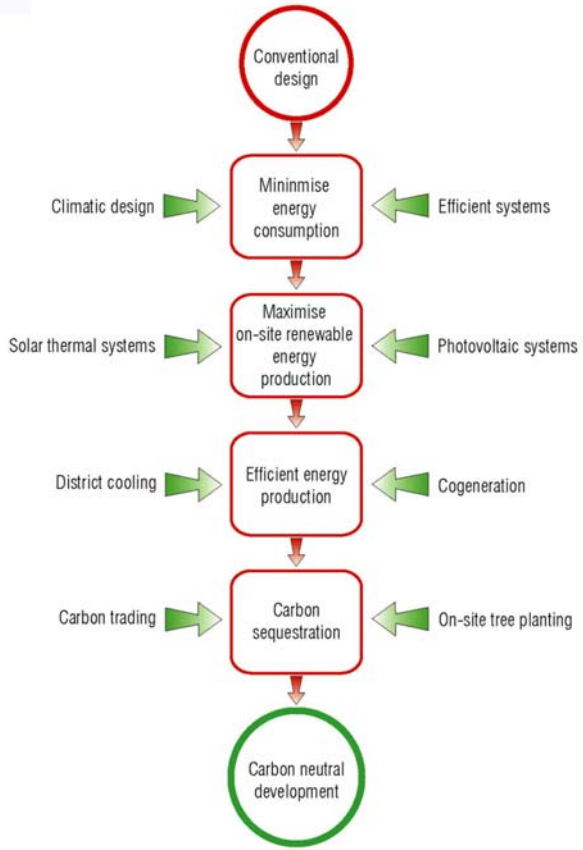
Carbon Neutral

-Building accounts for over 50% energy consumption.

-Carbon dioxide is produced as a direct result of energy consumption. It is one of the primary greenhouse gases which causes global warming and climate change.

-Masshouse offers an ideal opportunity to show how carbon emissions can be dramatically reduced through diligent planning, sustainable design and energy efficiency.





NIH SDI

Key Issues

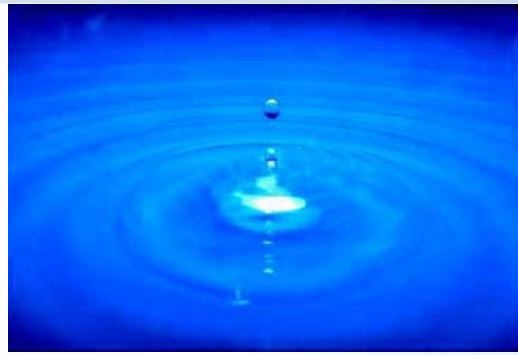
- Landscape
- Ecology
- Water
- Transport
- Microclimate and Air Quality
- Energy / MEP
- Waste and Materials
- Carbon

What Type of GREEN are we Talking about?

Labs are likely costing $3-4/cfm annually

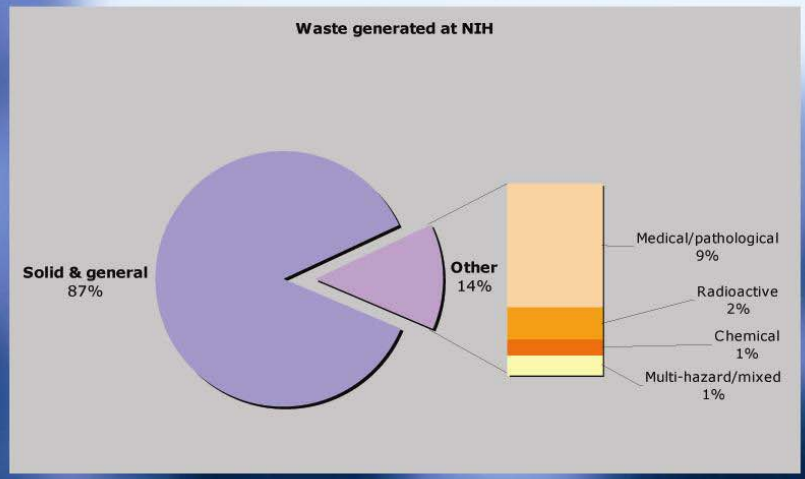
Translates to $7-10 million total cost

Example: The CRC building uses 1.2 million cfm/yr= ~$4 million cost



Water

- estimated 1.68 million gallons used daily
- $4.06 cost per gallon
- huge evaporative loss in cooling towers
- spending about $7.5 million annually on water



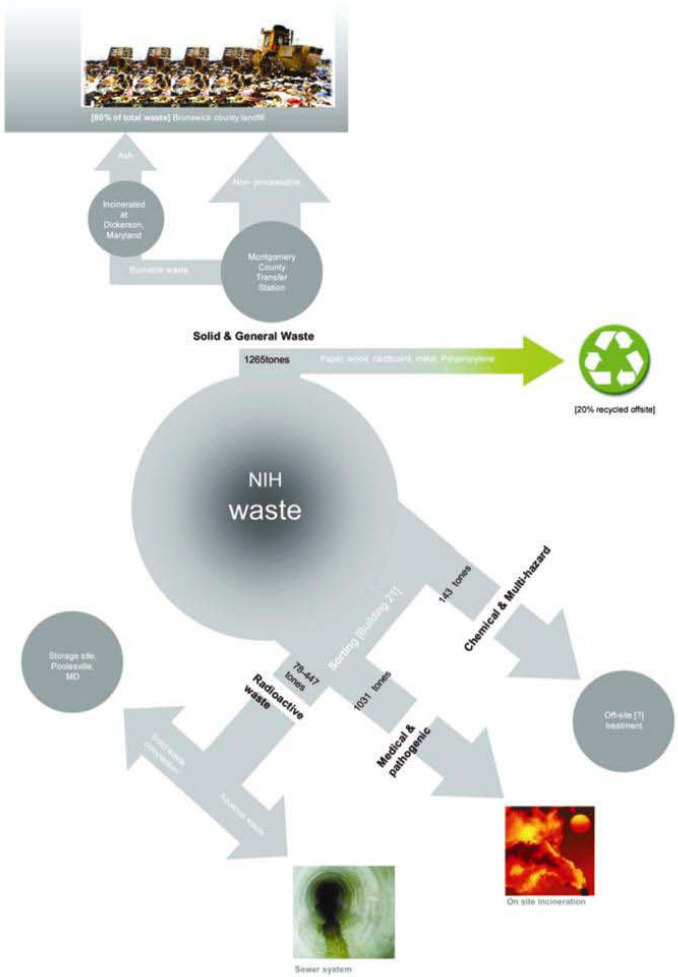
14,200 tons of waste generated annually

Waste & Materials

"Economies of Scale" Approach;

Types of Waste:

- **Solid/General**
- **Medical/Pathological (MPW)**
- **Chemical**
- **Radioactive**



Progress to Date:

"Greening the Government through Leadership in Environmental Management" (Executive Order 13148)

20-26% reductions in Solid / General Waste generated

23% reduction in Medical / Pathological (MPV) waste through minimization program.

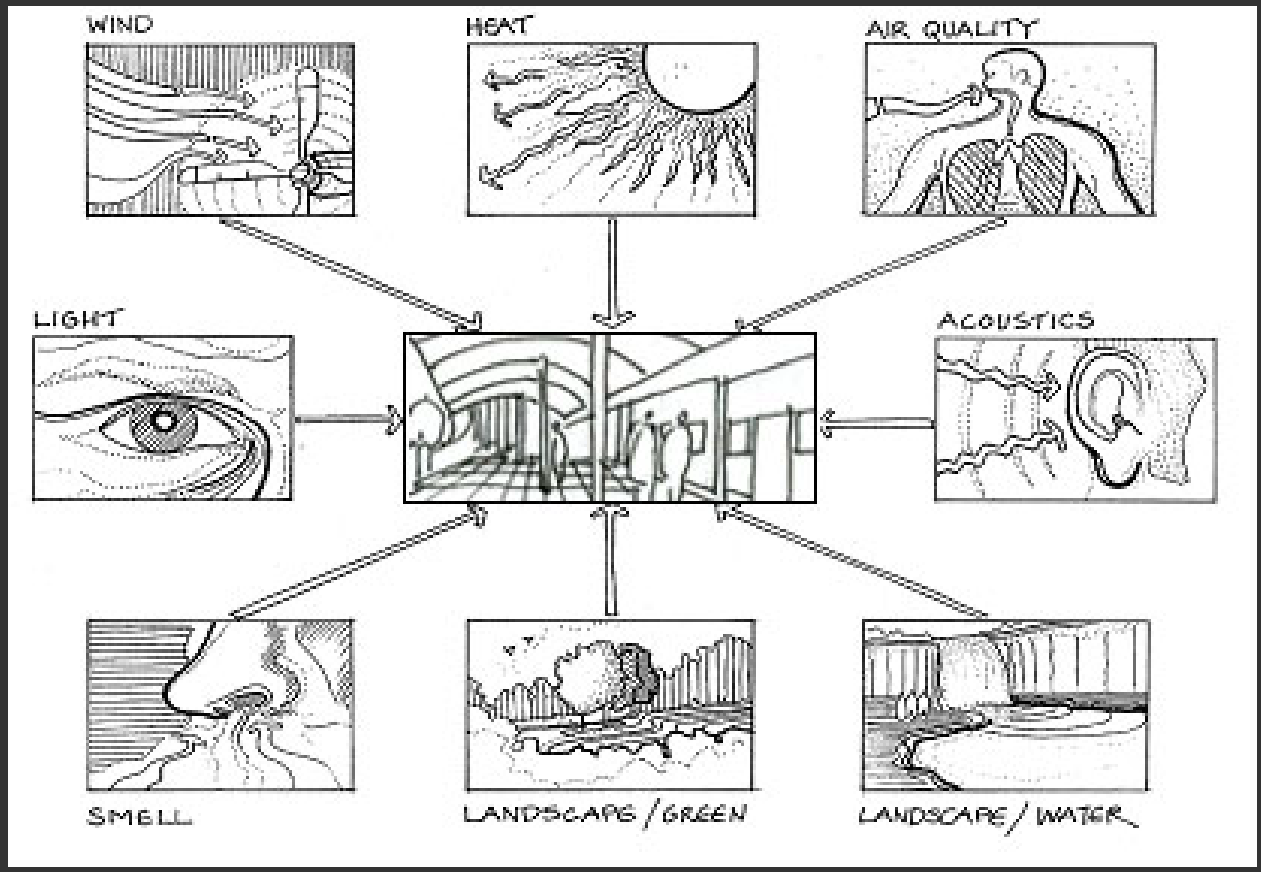
NIH SDI

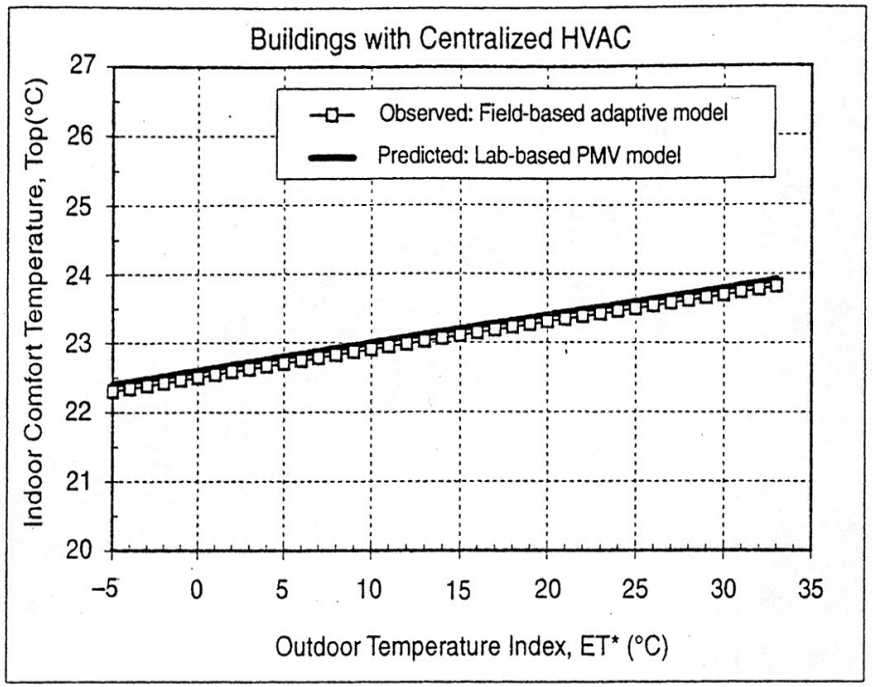
Economies of Scale, I think so…

Economic Impact: $1.7 billion in regional economic stimulus, 63,000 jobs generated by and around the Bethesda region.*

Source: Maryland Dept. of Economic Development, 1994.

What is Comfort?





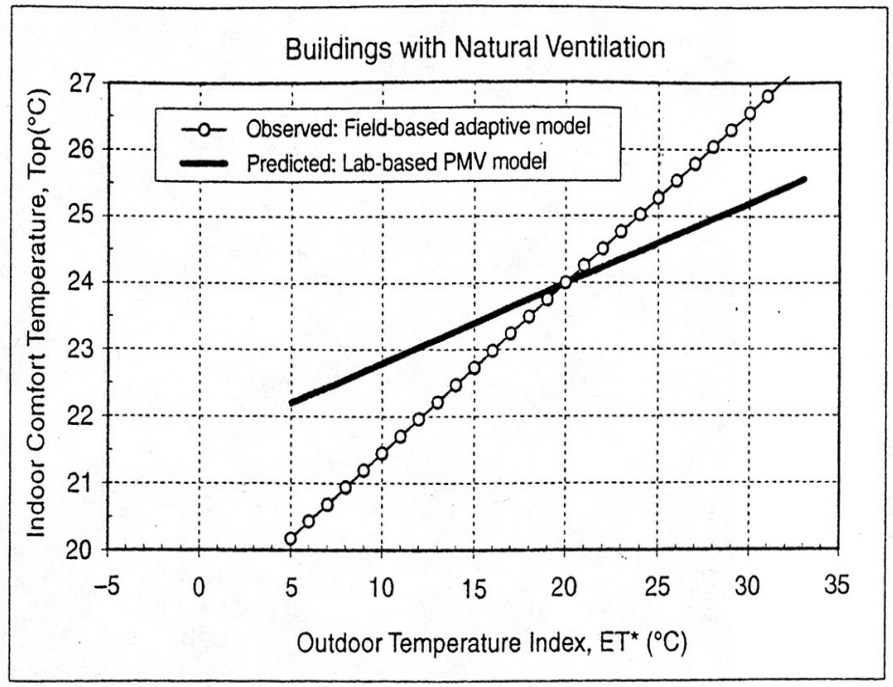
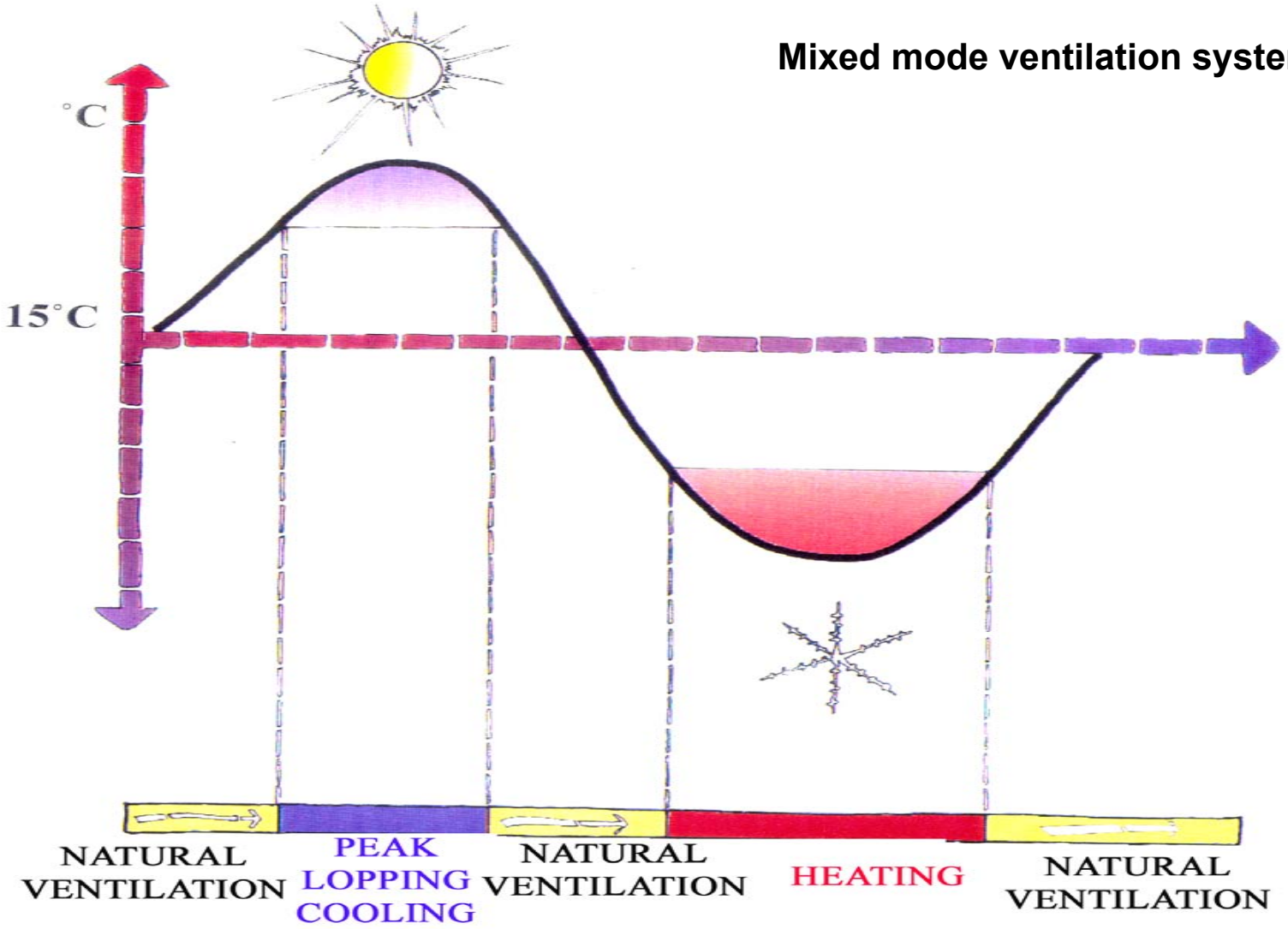
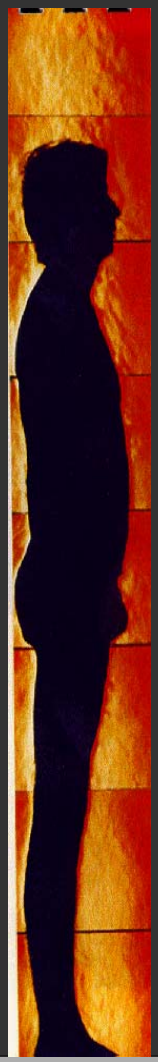


Figure 1: Observed and predicted comfort temperatures.

Mixed mode ventilation system





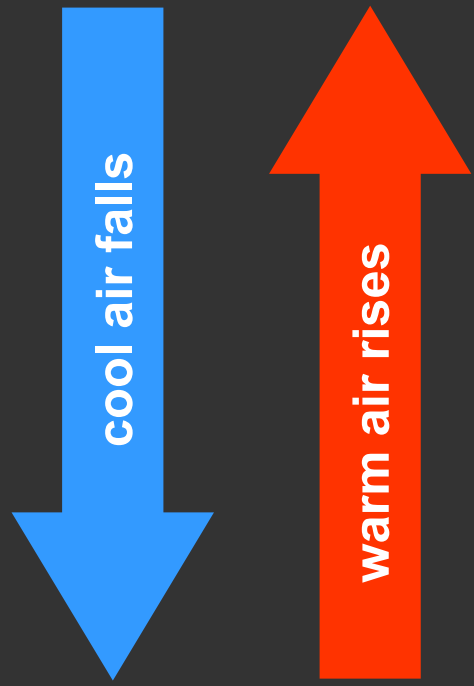
Natural Chimney

People release heat by convection.

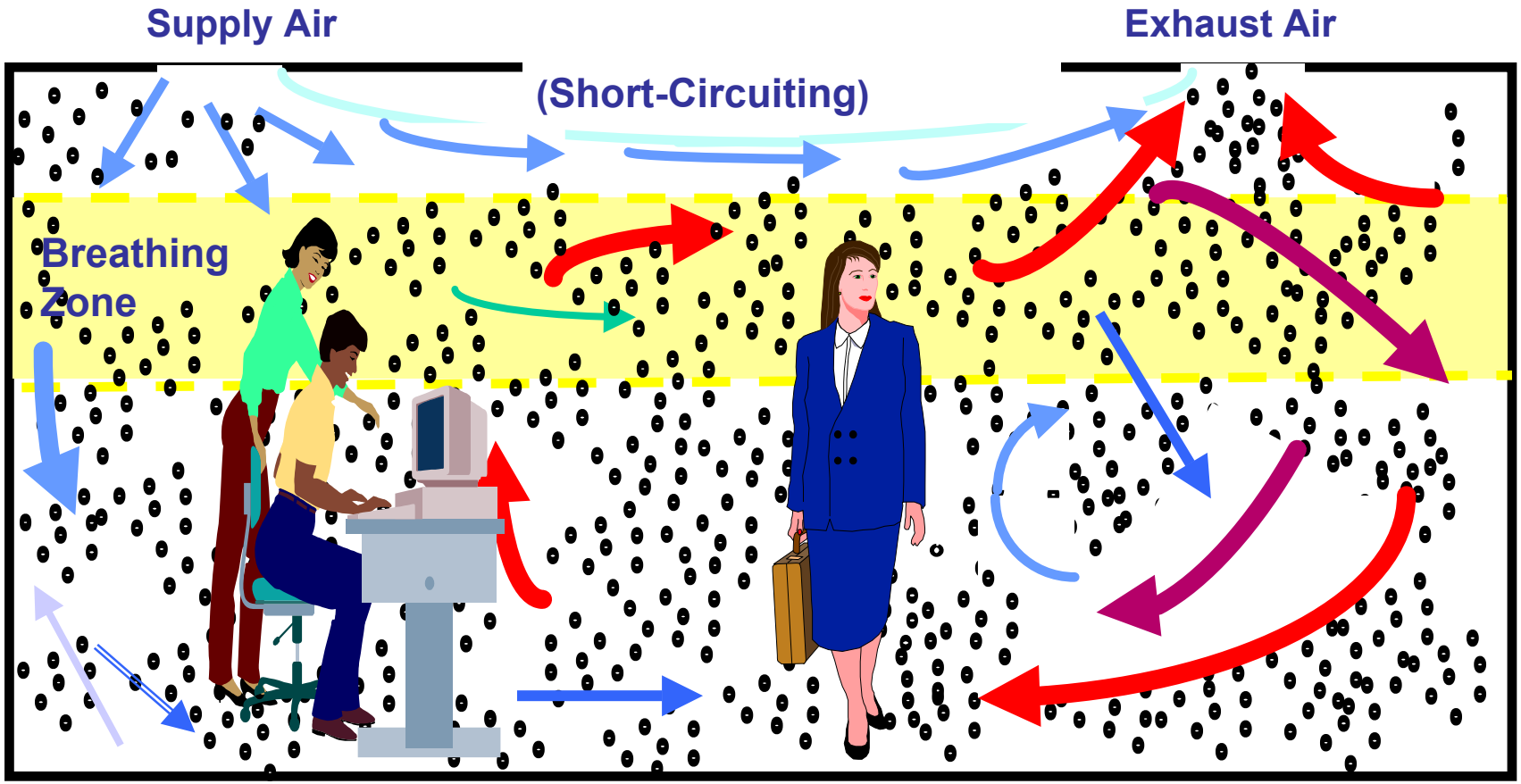
This heat rises in a plume around the person.

A mixing ventilation system then churns all this warm air to mix it with room air.

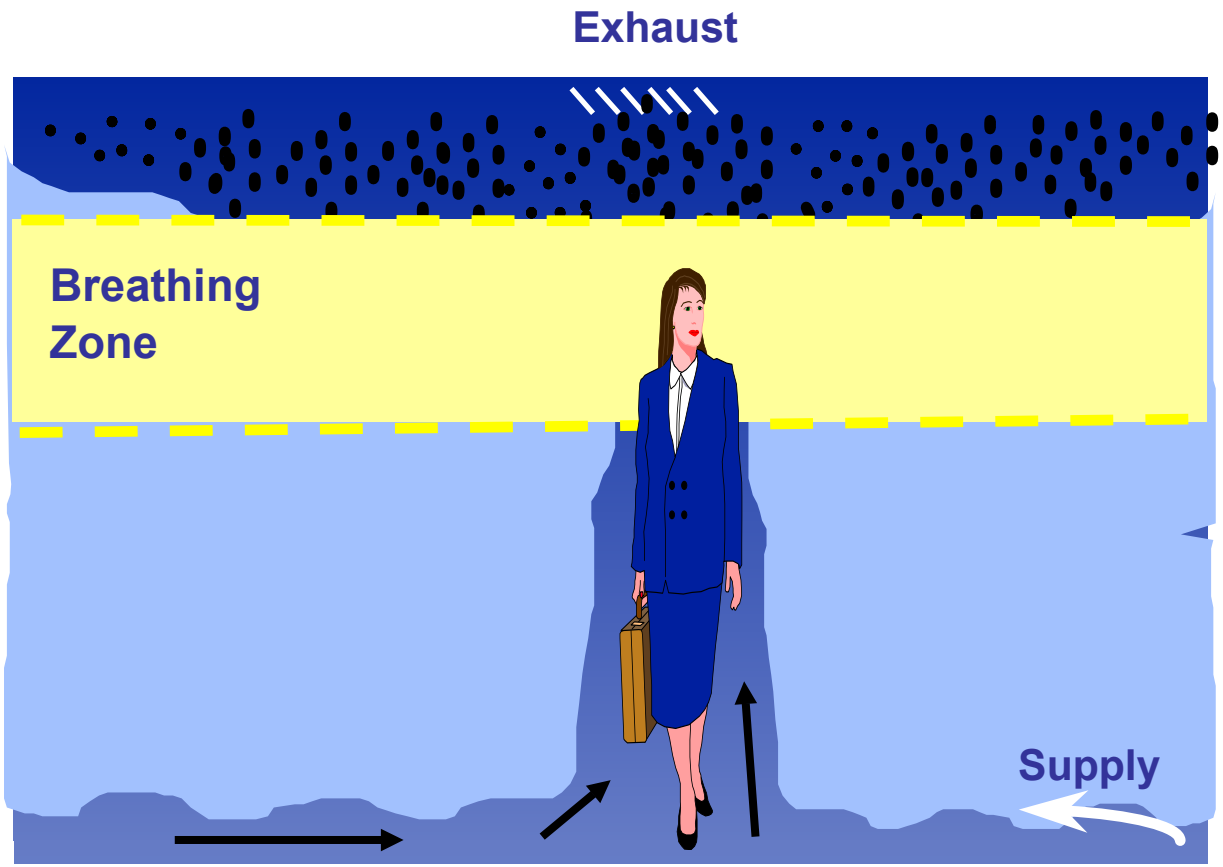
A displacement ventilation system uses the plume to move the warm air out of the occupied zone.

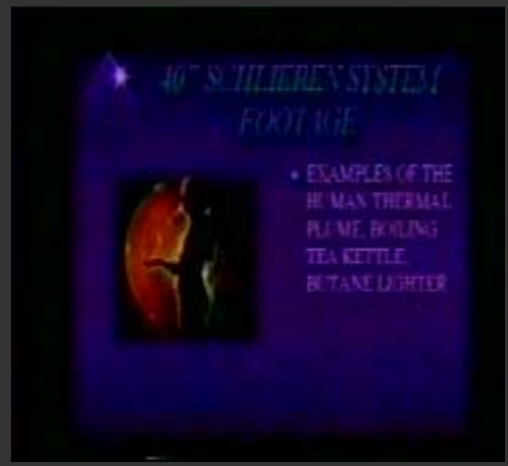


conventional mixing ventilation



thermal displacement ventilation





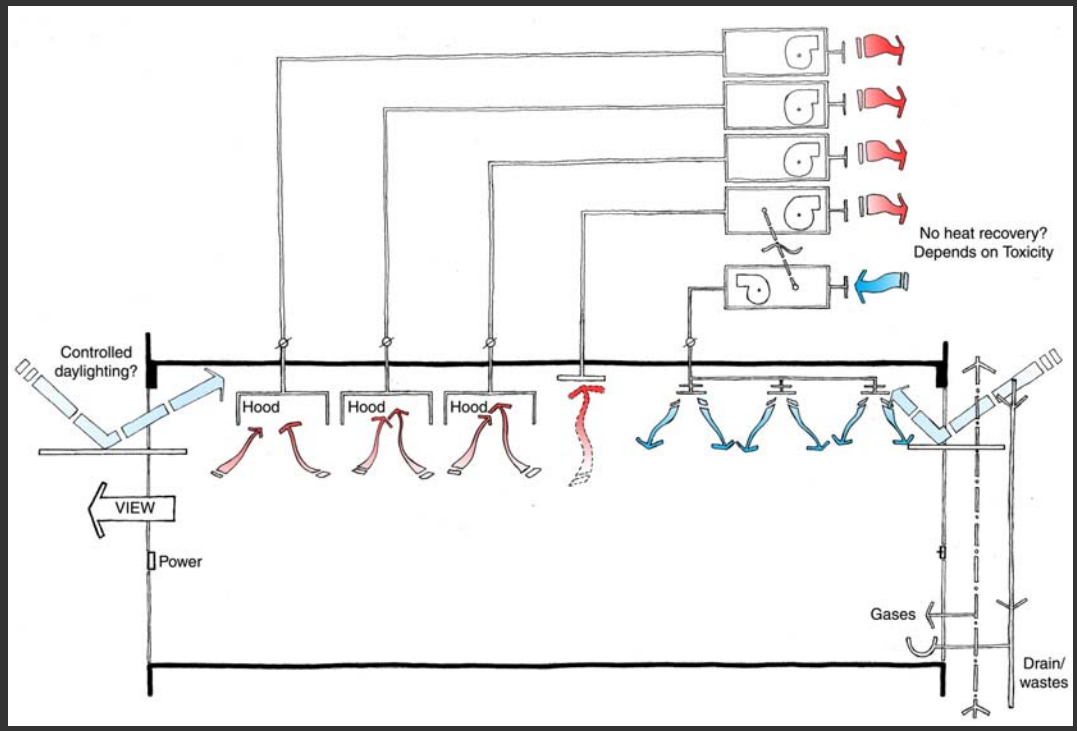
The higher the concentration of pollutants at the exhaust the better the system

Airborne pollutants are carried upwards by warm air

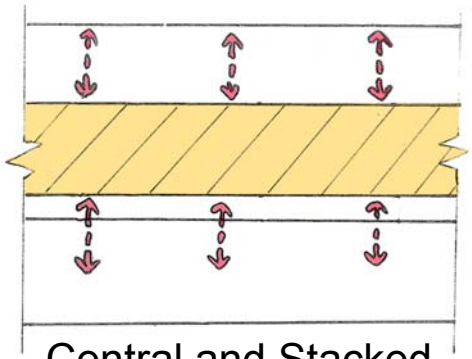
Key design Issues - Laboratories

- Location
- Space Minimisation
- Maximise “non-useable” space
- Flexibility
- Adaptability
- Maintainability
- Running Costs

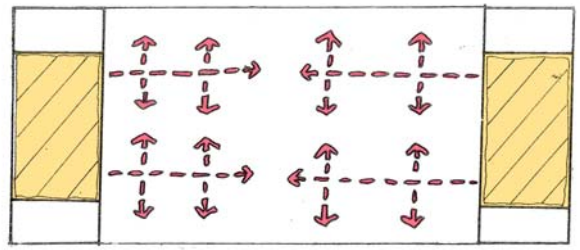
Laboratory Systems



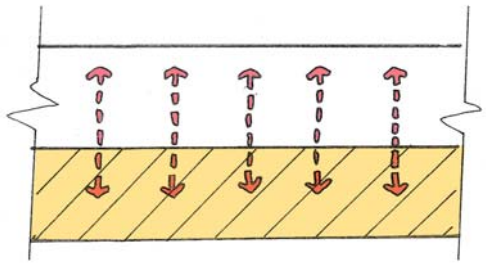
- Heat recovery depends on toxicity
- Large energy user
- Low Pressure loss duct work versus VAV
- Heat Recovery from refrigeration circuits from other building zones
- Free heating from geothermal
- Thermal storage /ice storage to offset peak demands



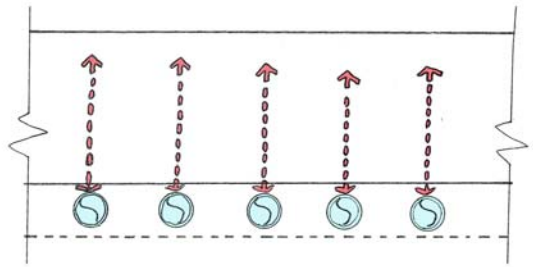
Central and Stacked



Distributed and Stacked



Interstitual



External Service Wall (Double Skin

Water

Building

- Minimise Consumption
- Look for Alternative Supplies
- Separate out “grey” water treatment onsite recycle
- Onsite blackwater treatment and recycling

Site

- Onsite Collection and storage of surface water
- Recycling for Landscape
- Recycling as greywater to W.C’s
- Onsite treatment of biological waste

- Architect who is inspired by it and can design it.
- MEP engineer who can join in and prove it
- Structural engineer who shares the vision
- Cost consultant prepared to believe that it costs no more
- A Client who wants it!!